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GEOLOGICAL AND MINING

REPORT

ON THE

LEINSTER COAL DISTRICT.

BY RICHARD GRIFFITH, JUN. ESQ.

INSPECTOR GENERAL OF HIS MAJESTY'S ROYAL MINES IN
IRELAND, MINING ENGINEER TO THE DUBLIN SOCIETY,
F. R. S. EDINBURGH, &c. &c. &c.



DUBLIN;

Graisberry and Campbell,

PRINTERS TO THE DUBLIN SOCIETY.

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TO THE
RIGHT HONOURABLE AND HONOURABLE
THE DUBLIN SOCIETY.

MY LORDS AND GENTLEMEN,

HEREWITH I have the honor of laying before you my Geological and Mining Report on the Leinster Coal District, accompanied by a Map and several Sections. I have also added Accounts and Plans of the most improved Methods of working Coal, as practised in England.

I hope the whole may prove acceptable to you, and beneficial to Coal Mining in Ireland.

I have the honor to be,
My Lords and Gentlemen,
Your most obedient humble servant,

RICHARD GRIFFITH, JUN.

MINING ENGINEER.

Dublin Society House, }
May 11th, 1814. }

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INTRODUCTION.

THE Mines of Ireland have hitherto been conducted on so rude and unscientific a system, that the ruin of those engaged in them has been almost invariable; and owing to the dread of mining speculations, which these failures have occasioned, the internal treasures of Ireland remain unexplored, although there is scarcely a county in the Island, which does not exhibit indications of valuable mineral productions.

Various plans have at different times been suggested, to remove a dread so injurious to the prosperity of the country, by introducing a regular arrangement in the working of mines, founded on scientific principles.

Our celebrated countryman, the late Mr. Kirwan, laid a proposal before Government for

a mining board, similar to those, under whose guidance the German mines are conducted; but it was imagined, that the control, which this Board was intended to possess over all the mines in the country, would interfere too much with the property of private individuals, and could not be carried into effect, consistently with the freedom of the British Constitution.

The late Right Honourable Charles Greville, the enlightened patron of mineralogical science, was also very anxious on this subject; and, a very short time previous to his lamented death, he addressed a letter to the Earl of Liverpool, pointing out the benefit, which Ireland would derive from a general examination of its mines and minerals.

It was, however, reserved for the Dublin Society to make the first efforts toward improvement, by setting on foot accurate and minute mineralogical surveys of the several mining districts of Ireland.

Their first attention has been directed to the coal mines of this country, and the mineralogical examination of the Kilkenny, or Leinster

coal district, which is one of the most important; forms the subject of the following Report.

When it is considered what vast sums of money have in almost every part of Ireland been expended, in searching for coal, where none was likely to be discovered, few will doubt of the benefit, which the country must derive from an accurate examination of each particular district, that exhibits indications of that valuable substance. Nearly the whole of the failures which have occurred, and certainly all those where fruitless searches have been made, have originated in the fraud, or ignorance of the agents employed. Many common English colliers have at different times been invited over to Ireland, to explore the country in search of coal; and, as few places could be selected, which do not exhibit some trifling appearances similar to those of a coal country, (any one of which is sufficient for a common collier to recommend the commencement of workings,) we need not be surprised at the number of trials, and consequent failures which have occurred. The most common of these supposed indications are chalybeate springs, which occur every where. They are met with very frequently throughout the

whole of the great limestone district of Ireland, which contains no coal, as well as in the coal countries. Chalybeate springs can therefore be no indication of coal.

Slate-clay either black, grey, or reddish grey, is another supposed indication of coal, and is certainly common in all coal countries, but not peculiar to them. This rock is frequently found alternating with limestone, and particularly that species called *calp*, which occurs in the neighbourhood of Dublin.

This slate-clay contains balls of clay ironstone, another supposed indication; and, as chalybeate springs are also met with in great number, the *calp* country contains three supposed indications of coal. These appearances have been deemed quite conclusive in the eyes of many professed miners; and at their recommendation trials were made in many places to the North and West of the city of Dublin, particularly at Castletown, and near Lucan; and within this year by a gentleman close to the new Spa well, at Golden Bridge.*

* At the request of the proprietor I visited this quarry, and having examined it, was decidedly of opinion, that there was no probability of finding coal there.

Trials have also been made in various parts of the county of Meath, and some pits have been sunk in search of coal, in a transition clay-slate country, near Newtown-ards in the county of Down, and in other places, merely because the slate was coloured black, arising from the decomposition of some iron pyrites contained in it. In the trials near Newtown-ards, I have been credibly informed, that the colliers went so far as to say they found coal, and certainly raised some from the bottom of the pit, but it was as certainly taken down in the pockets of the colliers. This deceit has been practised more than once. It is unnecessary to enumerate here all the artifices that have been used, or the fruitless trials that have been made in search of coal in different parts of the country. It may be more useful to describe the different rocks, which are usually found accompanying coal. They consist of alternations of *sandstone*, *slaty micaceous sandstone*, or *sandstone slate*, *slate-clay*, *clay ironstone*, and *fire-clay*. Other rocks are however met with occasionally, as *lime-stone*, *porphyritic stone*, and *greenstone*.

The sandstone of the coal formation is composed of particles of siliceous sand of various

degrees of fineness, cemented together by a calcareous, or argillaceous paste. It frequently contains impressions of large reeds, and stems of trees, but they are merely impressions or casts on the sandstone rock; for no vegetable matter remains. Sometimes however, impressions of the branches of large trees have been discovered, and then a coating of coal is frequently found, surrounding the impression, and occupying the place of the bark. Coal sandstones are frequently micaceous; they sometimes divide into thin beds, and are used as flags. The Carlow flags are of this species. The hardness and compactness of sandstone differ very much in different coal districts. The sandstone of most of the coal fields of England, and Scotland, is found to be a cheap, durable, and ornamental building stone. The sandstone of the Leinster coal district is so extremely hard, and untractable under the hammer and chissel, that no use is made of it, except in the roughest buildings. This is to be regretted, as sandstone is superior to limestone for building, in as much as it does not attract moisture in the same proportion. The usual colour of sandstone of the coal formation is yellowish grey, which passes into white; it is sometimes smoke-grey, and rarely

dark brown or red. The sandstone of the English collieries is generally yellowish grey; with us it is smoke-grey. Red sandstone occurs in the collieries of the county of Tyrone. At the Kilkenny collieries, sandstone is called rock, as grey rock, &c. to distinguish it from slate clay, which is there called slate. At Newcastle upon Tyne, it is called post, as white post, grey post, &c. and in Scotland freestone, or stone, simply.

Slaty micaceous sandstone, is a rock intermediate between sandstone and slate clay, and partakes of the characters of both. It is composed of particles of sand, cemented by an argillaceous paste, which predominates. It frequently presents a stratified appearance, from its being divided into laminæ, some of which contain more sandy particles than the other, and are of a different colour.

Slate-clay is usually the most abundant rock of the coal formation. It is a dull earthy mineral, which easily divides into thin laminæ or flakes. It decomposes rapidly, when exposed to the atmosphere. Its colour varies from black

to bluish black; sometimes it is grey, and rarely reddish. This rock often passes through the several gradations of slaty sandstone into sandstone, that is, the same bed is found in one part to be composed of slate-clay, and in another of slaty sandstone, and in a third of sandstone.

Slate-clay is sometimes so compact that it resembles jasper. In the Kilkenny coal district, instances frequently occur of its passing, by insensible gradations, from soft slate-clay into a siliceous slaty rock, resembling Lydian stone. This gradation is frequently visible in that district, near the junction of the limestone with the rocks of the coal formation. Slate clay frequently contains impressions of a great variety of vegetable substances, principally of ferns, and sometimes of aquatic plants. These impressions lie horizontally in the direction of the strata.

Mr. Jameson * says, that in the coal formation all petrifications of small plants and reeds are found in this position; but that the larger arborescent plants often stand erect, with their stems filled with the substance of the superin-

* Mineralogy, third volume.

cumbent strata, which seems to intimate, that these stems are in their original position.

Habel, in his "Natural History of Nassau," mentions, that he saw a petrified vegetable stem rise forty feet through rocks of the coal formation, and that the stem was one foot in diameter at one of its extremities.

Clay ironstone is generally found interstratified with slate clay, either in flattened spheroids detached from each other, or in beds, which frequently are only two or three inches in thickness, and rarely exceed six inches. This substance increases in weight, in proportion to the quantity of iron it contains. Its hardness is not great; it may easily be scratched by a knife. The fracture is conchoidal in every direction, and colour bluish black of various shades. Nearly the whole of our English iron is made from this substance, which sometimes contains 30 per cent. of iron, but rarely more than from 20, to 25 per cent.

Fire-clay is a substance, which has received no particular mineralogical name. Its colour is grey of various shades, but usually light smoke-

grey. It is very soft, and its fracture is earthy. This substance generally contains vegetable impressions of rushes, reeds, and other aquatic plants. I have given it the name of *fire-clay*, from its being used, when decomposed by exposure to the air, and ground fine, to make bricks or crucibles, which will stand the intense heat of our glass-houses and other furnaces. It is usually met with in the coal series, immediately below the coal. On this account, it has received the name of coal sill, or seat, at the Kilkenny collieries. In England it is generally called *thill* by the colliers, which name is also given to slate-clay. Fire-clay is found in great quantity, and of very superior quality, at Stour-Bridge in Worcestershire, and from thence it is exported all over the British empire, and to India and America. The fire-clay met with below the different beds of coal in the Leinster coal district, is so similar in its appearance, and quality, to the fire-clay of Stour-Bridge, that I was induced to make trial of it in the intense heat of a glass-house furnace; which it stood so well, that it was judged by all who witnessed the experiment, to be equal, if not superior to the Stour-Bridge clay. It is to be hoped, that this natural advantage may not be

much longer neglected, but that we may soon be able to supply ourselves, and even vie with our neighbours in the exportation of this very useful substance.

These five rocks, viz. sandstone, slaty sandstone, slate-clay, clay-ironstone, and fire-clay are met with in all coal districts. We shall now consider those rocks, which occasionally occur interstratified with them.

The limestone of the coal formation presents a dull earthy aspect. It is usually of a brownish or bluish grey colour, and frequently contains vegetable organic remains. Limestone of this species occurs in several coal fields in Scotland ; particularly near Paisley, and in the neighbourhood of Edinburgh. It also occurs in the bituminous coal strata of the county of Antrim, and in other parts of the North of Ireland. Porphyritic stone and green-stone are of very rare occurrence in coal districts ; neither of them have hitherto been discovered in Ireland, interstratified with rocks of the coal formation ; but green-stone has been met with in some of the Scotch collieries.

Coal strata do not appear to have any determinate order; the rock which forms the roof, being as often sandstone as slate clay. It sometimes even happens, that the same bed of coal is covered in one part by sandstone, and in another by slate clay. In the Leinster coal district, (as I shall in future denominate the coal district of the counties of Kilkenny, Queen's county, and county of Carlow,) slate clay is usually found to be the roof of the coal, and fire-clay the substratum in every instance, but one. This remarkable exception will be dwelt upon in its proper place. In examining the rocky bed of a stream, or a precipitous cliff, in search of coal, the greatest attention should be paid to the appearance of fire-clay, which is generally found a certain leader to a bed of coal, either thick or thin. In places of this description the coal is rarely to be seen, having been decomposed, and washed away at the edge; and the roof of the coal, whether sandstone or slate clay, is found in contact with the floor or fire-clay. Care must, however, be taken not to confound decomposed light blue slate clay, with fire-clay, as the external characters are very similar, and very difficult to be distinguished by an inexperienced eye. The difference, however, may be ascertained

with certainty, by subjecting part of the doubtful substance to a white heat, when the decomposed slate-clay will assume a red colour on cooling, and the fire-clay will become white, or yellowish white, and extremely hard. If the heat applied be strong, the fire-clay will be sufficiently hard to scratch glass.

OF THE COAL DISTRICTS OF IRELAND.

If we except the Leinster district, my knowledge of the coal districts of Ireland is as yet very limited. And, though each in its turn will form the subject of a separate Report, I think it right to draw attention to them in this place, by giving such general information as I possess, respecting their situation and circumstances. Coal has been discovered in more or less quantity in seventeen counties * of Ireland; but I

* The counties are, Antrim near Ballycastle; Donegal north of Mount Charles; Tyrone in the Ulster coal district, and at Drumquin; Fermanagh, north continuation of the Connaught coal district, and at Petigoe; Monaghan near Carrickmacross; Cavan near Belturbet; Leitrim and Roscommon in the Connaught coal district; Westmeath near Athlone; Queen's county, Kilkenny and Carlow, in the Leinster coal district; Tipperary, continuation of the same; and Clare, Limerick, Kerry, and Cork, in the Munster coal district.

believe the island contains but four principal coal districts, viz. the Leinster, the Munster, the Connaught, and the Ulster. The two former contain carbonaceous or stone coal, * and the latter bituminous or blazing coal.

The Leinster coal district is situated in the counties of Kilkenny, Queen's county, and county of Carlow. It also extends a short distance into the county of Tipperary, as far as Kille-naule. This is the principal carbonaceous coal district. It is divided into three detached parts, separated from each other by a secondary limestone country, which not only envelopes, but in continuation passes under the whole of the coal district; a fact, which was indisputably though accidentally, proved by the Grand Canal Company, who sunk a pit through eighteen yards of black slate-clay, and flinty slate, into the limestone in search of coal. The Leinster coal district is therefore of subsequent formation to the limestone.

It has been asserted by some philosophers, that this coal district belonged to the transition

* Slaty Glantz coal of Werner.

rocks of Werner ; and if so, the great limestone district of Ireland must be considered as transition * limestone. There are however strong grounds for believing that this is not the case. First, it certainly overlays the grey wacké country of Kildare, between Rathcoole and Kilkea Castle ; and along the junction, masses of coarse grained red sandstone are visible at the surface, but I never found any in *situ* in the whole line. However, the detached masses, which are found along the line of junction, and in no other place, prove that the native bed of the sandstone rock must be near the edge of the grey-wacké country, and it is most probably interposed between it and the limestone. That the limestone does actually lie above the sandstone in some places is certain. It may be seen at Castlebar, and in other parts of the county of Mayo. And as there is no interruption in the limestone country between Dublin, Castlebar, and Kilkenny, it is consequently similar in these places.

From the position alone of the limestone, it might be determined to belong to the floetz or

* The terms Primary, Transition, Secondary, Formation, &c. &c. have been adopted as words in common use, but in this Report no theoretical signification is meant to be implied by them.

horizontally stratified rocks ; but, as an additional proof, the characters of the limestone itself are different from those attributed to transition limestone, as the stratification of the former is for the most part nearly horizontal, and the rock contains irregular beds, and immense quantities of rounded masses of Lydian stone, much resembling the nodules of flint contained in chalk beds.

This rock also contains petrifications in profusion, as madrepores, hellecites, archites, entrochites, &c. From these data then, we may conclude, that the great limestone valley of Ireland is composed of *flætz*, not transition limestone, and consequently, that the coal strata, incumbent on it, cannot belong to the transition series. These observations may appear out of place in a practical work ; but the first step toward the general improvement of mining must be to diffuse a knowledge of the geology of the country ; and the more accurately, and scientifically we commence, the more perfect and satisfactory will be our conclusion.

The Munster coal district occupies a considerable portion of the counties of Limerick and

Kerry, and a large part of the county of Cork. It is by much the most extensive in Ireland; but as yet there is not sufficient information respecting the number, extent, or thickness of the beds of coal it may contain.

Coal and culm for near a century have been been raised in the neighbourhood of Kanturk in the county of Cork. At Dromagh colliery I understand the work has been carried on to a very considerable extent, and its annual supplies of coal and culm have materially contributed to the agricultural improvement of an immense extent of the great maritime and commercial counties of Cork and Limerick, which must other wise have continued neglected and unreclaimed.

Many circumstances combine to make the examination of this district of peculiar interest and importance,—and as a recent application has been made by the Cork Institution to the Dublin Society, to aid the undertaking, it is probable that this immense district will shortly be minutely explored; from all that has been ascertained it is very clear that the dip of the beds and the quality of coal differ materially from those of the Leinster district. In the Munster district

the beds run east and west, and dip to the south, forming an angle of forty-five degrees. In the Dromagh colliery, where all the beds which have been discovered have been successively and in general successfully wrought, four beds incline on each other, and at no greater distance than 200 yards. The first of these beds is a three feet stone-coal, and is the leading bed. All faults, checks, and dislocations, similar to those which are discoverable in this bed, are in general to be encountered in the other three; the names of the four beds are, the *coal bed*; this lies furthest to the north; the *rock-coal*; so called from its being comparatively of harder quality than the other beds; the *bulk bed*; so called from its contents being found in large masses or bulks; and *Bath's bed*; so called from the name of a celebrated English miner, by whom it had been many years ago discovered and worked; the coal bed consists of three feet solid coal, and is not sulphureous; the rock-coal, is nearly of the same thickness with the leading bed, but is very sulphureous, and having the soundest roof is the most easily wrought. The other beds are of the culm species, but of peculiar strength. Each barrel of culm has been ascertained to burn from nine to ten barrels of lime. The bulk bed

forms immense bulks and masses of culm, in which the miners have frequently been unable to retain the ordinary directions of roof and seat.

No work has been undertaken in the Munster coal district to a greater depth than 80 yards. The present work at the Dromagh colliery is at that depth. It is heavily watered, and consequently expensively wrought. The quality of the coal and culm improves as the work descends. Mr. Leader, who is the proprietor of the Dromagh colliery, has kindly communicated to me all the surveys and reports, which, from time to time, have been received from the persons who have inspected and directed the works. The peculiar proximity of the beds, and the extraordinary diversity of their contents in the Munster district make the minute examination of this coal-field of deserved interest and importance to this country. The time I trust is not remote, when the great coal field on the left bank of the Blackwater will be found to contain mineral treasure altogether inexhaustible, and by the liberality of Parliament, and the judicious and patriotic exertions of the Directors of Inland Navigation, fully adequate to all purposes of domestic convenience, and of national utility.

The Connaught coal district stands next in order, of value, and importance, to the Leinster and Munster, and possibly may be found to deserve the first place, when its subterranean treasures shall be explored. At present nothing is known, except, that the outer edges of several beds of coal have been observed, but they have not been traced to any distance; so that their extent is by no means ascertained. The coal is of the bituminous species. This coal is particularly adapted to the purposes of iron works, foundries, &c. &c.; and the grey pig iron made at the Arigna iron works is among the very best smelted in the Empire. Lough Allen, the source of the River Shannon, forms a basin in the midst of this great district, which on this account appears to be formed by nature for industry and commerce; but the navigation has been neglected, and is at present in such a state, that none but boats of trifling burden, can ply on the river, between Lough Allen, and Lanesborough. However, the Directors General of inland navigation in Ireland are at present employed in completing the Royal canal, between Coolnahay and Tarmonbarry on the river Shannon; and it is to be hoped, that they will at the same time complete a navigable communication

between Lough Allen and the Shannon; and repair and improve the navigation of that river downward to Lanesborough. This would be a sufficient inducement to the proprietors of coal in the neighbourhood of Lough Allen to open their works to a considerable extent, as they could not fail of having a very large demand for their produce, whenever the navigation between the lake, and the Shannon, shall be completed.

The Ulster coal district is of trifling importance, when compared with the foregoing. It commences near Dungannon, in the county of Tyrone, and extends in a northern direction to Coal island, and in continuation to the neighbourhood of Cookstown. No beds of coal worth working have hitherto been discovered between Coal island and Cookstown, but certainly the coal strata extend there. The principal collieries are at Coal island and Dungannon. The coal of this district is bituminous. I understand that indications of coal have been observed at Drumquin, in the county of Tyrone, and also at Petigoe to the north of Lough Erne. Possibly the coal formation may extend from the neighbourhood of Cookstown, westward to the north of Lough Erne.

Besides the foregoing principal coal districts, there are others of less consequence. Bituminous coal has been found in the neighbourhood of Belturbet, in the county of Cavan, and at the collieries of Ballycastle, in the county of Antrim; but the Antrim coal district is not very extensive. These collieries have been wrought for a number of years. The coal is of a slaty nature, and greatly resembles both the coal, and the accompanying rocks, which occur in Ayrshire, and probably they belong to the same formation. A very extraordinary discovery was made at these collieries about the year 1770. It is thus described by the Rev. Dr. Hamilton, in his Letters on the North Coast of the County of Antrim. "The miners in pushing forward an adit or level toward the bed of coal, at an unexplored part of the Ballycastle cliff, unexpectedly discovered a passage, cut through the rock. This passage was very narrow, owing to incrustations formed on its sides. On being sufficiently widened, some workmen went through it. In minutely examining this subterranean wonder, it was found to be a complete gallery, which had been driven forward, many hundred yards, into the bed of coal; it branched out into 36 chambers, where coal miners had

carried forward their works; these chambers were dressed quite square, and in a workman-like manner; pillars were left at proper intervals to support the roof; and in short it was found to be an extensive mine, wrought by a set of people, at least as expert as those of the present generation. Some remains of the tools, and even of the baskets used in the works, were discovered, but in such [a] decayed state, that on being touched they fell into pieces. Some of the tools appear to have been wood thinly shod with iron.

The great antiquity of this work is evident, from the fact, that there does not exist the most remote tradition of it in the country; but it is more strongly demonstrable from the sides and pillars being found covered with sparry incrustations, which the present workmen do not observe to be deposited in any definite portion of time.

The whole of the coal districts, which, as far as I know, occur in Ireland, have now been mentioned. Trials have, however, been made at Slane on the river Boyne, and also in the neighbourhood of Balbriggan and Rush. These

trials were however on the edge of the district, near the junction of the limestone. If the country contain coal, it will more probably be found in the interior than on the edge of the district. From this brief account of the coal districts it appears, that very extensive tracts of coal country exist in Ireland; but none, if we except the Leinster district, have been examined; yet the Munster coal district is in extent greater than any in England, and may probably contain inexhaustible beds of coal.

GEOLOGICAL AND MINING SURVEY

OF THE

LEINSTER COAL DISTRICT.

THE Leinster coal district is situated in the south-eastern branch of the great limestone district of Ireland, and the coal strata rest upon the limestone rock. This district of coal occupies small portions of the Queen's county, and the counties of Carlow, Kilkenny, and Tipperary. It is divided into three distinct parts by limestone rocks, which rise from beneath the coal strata.

Nearly the whole of the coal, that has been hitherto discovered, or that I have been able to trace, is contained in the eastern and most extensive division; toward which my attention has consequently been particularly directed.

This part of the coal district is bounded on the east, west, and south, by two great rivers, the Barrow and the Nore, which run immediately at the base of the colliery hills. The Barrow is navigable from Athy, where it joins the Grand Canal to the sea, below Waterford. The navigation of the Nore is of little use in its present neglected state.

The general appearance of the coal country, when viewed from a distance, is that of a very steep ridge of high land, running in a direct line many miles, rising from 800 to 1000 feet above its base, and apparently flat on the summit. It preserves this character on every side. But when viewed from the eminence itself, it resembles a great barren table land, rising precipitately above a flat and highly cultivated country.

It has already been observed that the coal country is surrounded by, and rests upon limestone. This limestone exhibits some remarkable appearances in the neighbourhood of the coal strata. It is not meant to theorise on these appearances, but as they are uncommon facts, a brief description of them may be useful.

The most important are the great dislocations, which have evidently taken place at, and near, the point, where the coal strata cover the limestone—the parallel disturbance in the coal strata, and the apparent change in their nature; the occurrence of irregular beds and veins of brown spar rock (siderocalcite of Kirwan) tra-

versing the limestone, and frequently containing angular fragments of it, which have been detached from the rock; and lastly the vast caves of limestone, which occur near the point of junction of the calcareous and coal strata.

In examining the limestone strata on any side of the coal country, the appearances are so similar, that a description of one part will give a perfect idea of the whole. We may select therefore the limestone valley between the granite country, two miles to the east of the town of Carlow, and the coal country two miles to the west. The limestone valley is only four miles broad at that point, and on this account it has been chosen as the line of the great east and west section (No. 2.) which comprehends in a small extent a granite, limestone, and coal country.

DESCRIPTION OF THE LIMESTONE VALLEY.

At the base of Brown's hill, two miles to the east of the town of Carlow, the granite country is covered by stratified siliceous limestone, dipping 60° west of north, at an angle of 10° from the horizon. The colour of the limestone is light greyish blue. It contains numerous petrifactions, chiefly of bivalve shells, and burns into

lime with great difficulty. The analysis of it is as follows ;

Carbonate of lime.....	95.
Silica with a tinge of iron...	4.50
Carbon.....	0.50
	—
	100.
	—

The stratification is quite regular between the granite country and Carlow ; but the colour and character of the limestone change, as the beds accumulate, or as they are further removed from the granite. Half way between the junction of that rock with the limestone, and the town of Carlow, the colour of the limestone is dark blue, and madripores are visible, but rarely any other petrifications. The beds in this part are extremely vesicular, and the numerous cavities are coated by a series of different fossils ; that next the limestone is generally calcareous spar, which is covered by crystallised siderocalcite or brown spar, from which numerous rock crystals shoot in every direction. Sometimes crystals are found detached, having the prism and both pyramids quite perfect.

On approaching to Carlow the limestone becomes more siliceous, and of a still deeper colour. In the quarries at the town, the colour is black, and the texture fine-grained ; and it is cut and polished, and used for chimney pieces, which are similar to those of Kilkenny ; but, as the rock is not quite so close-grained, the lustre

of the polished surface is less striking. The limestone to the west of Carlow is of a lighter colour, and much purer, than to the east. In the western quarries, for the first time, Lydian stone makes its appearance in quantity, both in irregular beds, and round nodules. The limestone becomes still lighter in colour, and finer in quality, as we ascend toward the base of the colliery hills. Some specimens of it, from the highest quarries, were found to be composed solely of carbonate of lime, with a trifling residuum of carbon, less than one quarter per cent. The number of petrifications in the upper quarries is immense; they consist chiefly of madrepores, encrinures, trochites, camites, pectinites, hellicites, mitillites, &c. &c.

On approaching the point, where the coal strata join the limestone, the stratification is generally disturbed; and the rock, from being solid and compact in its nature, becomes shivery, and breaks into indeterminately angular fragments of small dimensions. The quantity of Lydian stone is greatly increased; the actual point of contact of the limestone and coal rocks is rarely visible, owing to the great disturbance and dislocation of the strata. At Spring-hill, two miles to the west of Carlow, this shivery limestone is covered with about thirty feet of Lydian stone, arranged in very thin beds, which rarely exceed two inches in thickness. The stratification undulates and varies so much, that it is almost impossible to trace it. The Lydian

stone appears to pass into slate clay, and certainly no division exists between them. Specimens may be easily collected, forming a perfect transition from the Lydian stone, with a large conchoidal fracture in every direction, passing through a bed of indurated slate, (which has an earthy conchoidal fracture, and rings when struck) to the perfectly soft black slate clay which succeeds. These appearances are more or less striking in different places. They are peculiarly evident to the south of Spring hill, and at the limestone quarry to the south of Old Leighlin. In the latter place the Lydian stone contains numerous siliceous petrifications. The disturbance of the limestone and the coal strata are also very visible at this quarry, twenty yards from the junction of the limestone, dips 55° E. of N. at an angle of 10° from the horizon; approaching close to the hill, the angle of the dip increases to 20° .; at the junction, or where the limestone is covered by flinty slate, to 40° . However the stratification is not regular for ten yards in any direction. The dip of the coal strata on ascending the hill is at first equal with that of the limestone and flinty slate, but it gradually becomes flatter, and at the summit the inclination does not exceed six degrees from the horizon.

The succession of rocks, visible at Old Leighlin, is as follows, commencing at the bottom of the quarry, and ascending.

	FEET.
1. Dark bluish grey limestone.....	10
2. Irregular black Lydian stone, containing siliceous petrifications.....	2
3. Light grey limestone, (shivery in the beds, the uppermost contain Lydian stone).....	20
4. Lydian stone, containing numerous siliceous petrifications.....	3
5. Flinty slate, in very thin beds, the uppermost of which graduate into slate clay, and contain balls of clay ironstone of a dark blue colour.....	30
6. Sandstone flag.....	200

This rock continues to the summit of the hill, where it varies very much in quality, and passes, from hard sandstone, into soft micaceous flag which divides into thin laminæ, from one inch to one tenth of an inch in thickness.

Beside the irregularities above described, beds of brown spar rock * are frequently met with near the point of junction of the limestone, and the rocks belonging to the coal series. Examples of this nature are more frequent on the southern and western boundaries of the coal district, than on the northern and eastern. At

* Brown spar (the siderocalcite of Kirwan) is described, in all treatises on mineralogy, as a simple mineral which is usually found in veins, but I believe no mention has hitherto been made of its occurring in vast beds interstratified with limestone.

Jenkinstown, and to the north-west of it, the brown spar rocks occur very frequently in great quantities, particularly at Tullyglass. At this point the strata dip north at an angle of 7° from the horizon. The section visible is as follows: First light blue limestone, then brown spar rock, which varies from greyish blue to a yellowish white. This rock is highly crystalline, and frequently contains madrepores, but I never observed any other species of petrification. The brownspar is covered by flinty slate, over which is a perpendicular cliff, of yellowish brown sandstone of a shining lustre, which when struck, flies into small angular fragments, generally of three sides only. The face of the rock frequently assumes a columnar appearance, and many of these three-sided columns, (if I may so call them) are three or four feet long, and six inches broad on each of the faces. The peculiar character, and remarkable appearances of the brown spar rock are not so clearly exhibited near the junction of the calcareous and coal strata, as in some places a short distance from them. The calcareous cliffs on the north side of the river Nore, between Kilkenny and Bennet's Bridge, are well worthy of attention, as they bring to light some curious facts. The accompanying sketch (Plate I.) of their general appearance, will serve more clearly to elucidate the following description.

The first rocks visible are the limestone quarries at Sign, close to Kilkenny. In these quarries there are five beds of limestone, each about five feet thick. They increase in darkness of colour and fineness of grain, in proportion to their depth. They dip to the east. Below the quarry, near the bank of the river Nore, there is a cliff of brown-spar rock, which covers the limestone. The beds seldom exceed two feet in thickness. The colour of the upper beds in the cliff is yellowish white, but the lower are of a dark greyish blue colour, and contain madrepores. In one part of the lower bed, an irregular junction of the limestone with the brown spar rock is visible, the latter resting on the former, but not adhering to it. The brown spar rock extends a considerable distance down the river, but it is visible only at intervals, being covered with clay and gravel. Below the mills there is a low cliff of this rock; the beds dip to the east, and are evidently a continuation of the first cliff. Three quarters of a mile further down the river, *limestone* rocks appear forming a crag about eighty yards long. The dip here is west, and from this change we may conclude that the limestone rocks form a basin, the centre of which is filled up with brown spar, as represented in the accompanying section.

This supposition is strengthened by the fact that the limestone does undulate in the cliffs, on the south side of the river, between Archer's

Grove and Kilkenny. Lower down, though not exactly at the edge of the river, the limestone again dips east, and covered with brown spar, which extends to the marble mills. At this point the limestone again appears dipping west, and evidently passes under the brown spar. Below the marble mills, the limestone extends for a quarter of a mile, and forms a perpendicular cliff. As it approaches a little valley, the rock is covered with limestone gravel, but certainly extends as far as the valley, and there ends abruptly. On the opposite side, brown spar rocks commence, and continue for a considerable distance in regular beds: this regularity is at length interrupted by immense masses of limestone being found *enveloped* in the brown spar rock. These masses are so large, that the stratification still remains, although the extremities and edges are much shivered and broken.—See Sketch Plate, No. 1. The whole cliff is however quite solid, and the brown spar appears to have insinuated itself into all the crevices and fractured parts of the limestone. Beyond the extremity of the last included mass of limestone, the brown spar forms an irregular vein, between the included mass, and a cliff of limestone, which commences on the lower side. This vein (if it may be so called) is completely united and continuous with the beds of brown spar, both above, and below the included mass of limestone.

Below this extraordinary place the cliff is composed of regularly stratified limestone, for one hundred yards in length, when it is traversed by an irregular vein of brown spar, running north east, and dipping south east. A short distance beyond is a second vein, containing much calcareous spar, and some small angular fragments of limestone; and afterwards the limestone cliff is traversed by a third vein of brown spar, similar to the first. Beyond this vein, the limestone cliff remains undisturbed for a quarter of a mile, and then ends abruptly at a narrow glen, forming a perpendicular cliff. On the opposite side of the glen, strata of brown spar commence with equal abruptness, and continue without interruption to Bennet's Bridge, where they are covered by hillocks of limestone gravel. These latter beds of brown spar dip 30° west of north; the colour varies from brownish red to reddish white. The mass is extremely compact, and highly crystalline when fresh broken, but when exposed to the atmosphere the surface generally decomposes.

The abruptness with which the limestone and brown spar rocks end and commence, is observable in many places in the neighbourhood of Kilkenny, as well as in those I have mentioned; and where it takes place, these rocks are generally separated by a deep and narrow glen. Perhaps the most remarkable example of this fact is at Coolgrany, four miles south east of Kilkenny.

At this place there is a deep glen running south from the colliery hills. It is bounded on the east and west sides by perpendicular cliffs, which resemble each other so much both in the thickness and general character of the beds, that without further examination it might naturally be concluded, that at some period, a torrent of water had carried away the rocks that originally filled up the space between the cliffs. On nearer inspection, however, it will be found that the rocks on the west side are composed of brown spar, and at the east of blue limestone. The strata on each side dip 30° east of north at an angle of 10° from the horizon.

The third, but perhaps the most remarkable phenomenon that is met with in the limestone country, is the frequent occurrence of caves of various sizes, in the limestone, close to the point where the coal strata cover that rock. The caves of Dunmore and Clopooke, the one situated to the south and the other to the north of the coal district, are among the most extraordinary in the empire. Considerable streams of water flow out of the cave at the Peak, and others in Derbyshire, which are also in limestone. Many have attributed their origin to the constant friction of the water, but no water issues from the caves of Clopooke and Dunmore. Those of Clopooke are on an elevated situation, are very numerous, and are generally

in the form of long and narrow passages. Approaching the cave of Dunmore, you descend into a deep, circular, open cavity, at the bottom of which you descry the rude but magnificent entrance to the cavern.

Without theorising on any of the facts above described, we may fairly draw this general conclusion, that great convulsions have taken place at some period in the neighbourhood of the Leinster coal district, which have not only caused great irregularity in the stratification of the exterior boundary, but also throughout the whole of the interior of the district.

DESCRIPTION OF THE PRINCIPAL DIVISION OF THE LEINSTER COAL DISTRICT.

The largest and most important division of the Leinster coal district, is 15 miles long, between Timahoe, on the north, and Kellymount on the south; and 11 miles broad, between Ballickmoyler on the east, and Ballyragget on the west.

It has already been mentioned that the district is surrounded by limestone, which inclines or dips on all sides toward the coal country, and that the coal strata rest on the limestone, and dip conformably with it.

The character of the interior of the coal country is wild and dreary, the greater part being uncultivated, and nearly uninhabited. The surface is very uneven, and the hills of the interior, though less elevated, are similar in appearance to those which compose the outward boundary; being formed into steep, straight and long ridges, which are nearly flat on the summits.

The soil on the surface is generally composed of stiff clay, either yellow, blue, or white, and the summits of the hills are invariably covered by shallow bog.

There are two great vallies in the interior of the coal district, those of the rivers Dinan and Deehan. The former has its source near the summit of Clogrennan-hill, which bounds the coal country on the east, and runs westward by Coon, Uskerty and Damerstown, where it is joined by the Deehan; it then bends its course to the south-west, and falls into the river Nore, below Jenkinstown. The river Deehan has its source near the northern boundary of the district, and running south-west by Clogh to Castlecomer, joins the Dinan, a mile and a half below that town. The banks of these rivers are generally extremely steep, and are frequently composed of clay mixed with limestone gravel. This most useful substance also occurs on the most elevated ground in the coal country, form-

ing small hillocks or caps on the summits of the hills.

OF THE STRATIFICATION.

On taking a general view of the stratification of the Leinster coal district, such a picture of dislocation, undulation and irregularity, presents itself that it is almost impossible to understand, or trace any bed for a mile in length; and nothing but constant recurrence to the same place, and familiar acquaintance with the external aspect of particular beds of sandstone, has enabled me to ascertain with any precision, the extent and relative positions of any two beds within the district.

The stratification of the exterior hills of the district, on every side, is found to incline toward the interior of the coal country, and nearly at right angles with the declivity: on reaching the summit, the strata continue the same inclination, and are found to dip nearly parallel to the slope of the hill. On meeting one of the interior hills, the dip frequently changes to that of the inclination of the hill, and the strata bend over on the summit forming a saddle back, and descend into the next valley: on meeting a second hill, the inclination of the strata again changes to that of the

hill, and so on across the country. This is the character of the stratification, on the great scale; but in addition there are minor undulations, and such frequent slips * or down throws of the strata, as almost to baffle research.

That part of the coal district, situated to the north of the river Dinan, and east of the Deehan, is by much the most regular, and is the chief repository of coal. To the south side of the Dinan and west of the Deehan, no coal worth working, except that of Firoda, has been discovered; and from my own observations I am inclined to think none exists. If there does, the undulating stratification, which runs parallel with the irregular face of the country, would render it impossible either to work or unwater more than a few acres in any part.

The great section, plate 2, which crosses the coal district from east to west, affords an example of the regular and the undulating stratification.

Much time and labour have been expended in rendering this section as accurate as possible. The distances were ascertained by chaining the surface, and the heights partly by levelling, and

* By slips, or down throws is meant the sudden change in the level of the strata, which is frequently observable in all the coal fields, by the slipping or falling of one part of the coal field, from its original position to a lower one. This fact is clearly represented in plate, No. 3, where it is shewn that the coal strata, in the Lordship colliery of Castlecomer, have been thrown down 70 yards by a slip.

partly by angles of elevation and depression, taken with a large theodolite. The eastern part of the section crosses the most regularly stratified part of the coal district, and it is hoped by means of it to give an accurate view of the relative position and extent, in an east and west direction, of the different beds of coal and other substances as they occur, commencing with the lowest, which rests upon the limestone, and ascending regularly, ending with the uppermost bed of rock, which is met with in the district.

But previous to entering into the minute detail, either of the section or of the tracings of the different remarkable beds, it may be proper to give an outline of the general mode of proceeding, and the reasons for adopting that mode.

It has been the general opinion of the colliers, that there exists but one bed of coal in the Leinster coal district, and though it is admitted that the coal at different collieries presents different aspects, and is of various thickness, still those who think at all on the subject, attempt to account for these variations, by the disturbances and alterations created by slips and undulations of the strata, or faults, as the colliers universally term all irregularities. The first object was therefore to ascertain the real state of the case, and with this view the section, plate No. 2, was commenced; by means of it, and the section, plate No. 3, which crosses the

country nearly at right angles, to No. 2. It is proved to a certainty, that the district contains eight beds of coal, one above the other, all of which are workable; this being accomplished, the next object was to trace the line of the outgoing or crop of the lowest workable bed of coal in the district. This must at all times be an object of great importance to the mineral surveyor. It serves him as a line to bound the extent of his researches; and if he be acquainted with the perpendicular distance between the first and second beds of coal, by ascertaining the angle and direction of the inclination of the strata, he will by practice be enabled to determine with tolerable accuracy, the horizontal distance between the outgoings of the first and second beds, and so on to the third, fourth, &c. But this mode of proceeding becomes absolutely necessary in countries similar to the Leinster coal district, where the outward face of the boundary hills presents numerous deep gullies and mural precipices, in which the whole stratification of the mountain is exposed, but where the rocks of the interior of the district are almost universally hidden from view, by a deep clay covering. The plan which was pursued therefore of first tracing the lowest workable bed of coal round the district, as it is the only one that appears on the face of the precipices, was that most likely to lead to an accurate knowledge of the general stratification,

and the probable position of the outgoings of the different beds of coal, which occur in the interior.

For the sake of greater clearness the table of the different rocks represented in the sections, plates No. 2 and 3, is here given: the peculiarities and extent of such of the beds as may be useful or are remarkable, will afterwards be described.

TABLE.

No.		Feet.	Inches.
1	Limestone, which covers the Granite, about	3000	0
2	Black slate clay, which in the upper beds become greyish blue micaceous slate clay,	300	0
3	Alternating beds of sandstone and slaty sandstone.	25	0
4	Finegrained black slate clay	30	0
5	Alternating beds of sandstone and slaty sandstone	30	0
6	Greyish blue irregular micaceous slaty sandstone, which gradually passes into black slate clay, with iron stone.....	35	0
7	Grey micaceous sandstone.....	20	0
8	Spheroidal slate clay containing balls of clay, ironstone frequently one foot thick..	30	0
9	Grey sandstone in thin beds.....	32	0
10	COAL, slaty glantz or carbonaceous, in very thin laminæ, between black slate clay and fireclay.....	1	6
11	Small spheroidal slate clay containing clay ironstone balls.....	20	0
12	Irregular grey sandstone.....	8	0
13	Slate clay	1	0
14	Grey sandstone.....	10	0
15	Black slate-clay, containing beds of different thicknesses of clay ironstone, sometimes they are one foot	65	0
16	Calcareous sandstone.....	1	0

No.		Feet.	Inches.
17	Fireclay.....	0	6
18	Black slate clay.....	4	0
19	Blackish blue slate clay, containing thin but regular beds of clay ironstone.....	35	0
20	Calcareous sandstone.....	0	6
21	Calcareous fireclay, containing cornuam- monis.....	0	4
22	Black slate clay.....	6	0
23	Bluish black slate clay.....	85	
24	Alternating beds of sandstone, slaty sand- stone and slate clay.....	60	0
25	Very hard clayey sandstone, containing im- pressions of rushes.....	2	0
26	Fireclay.....	1	0
27	Rossmore COAL.....	0	10
28	Black slate clay.....	60	0
29	Grey sandstone, with thin beds of slate clay	45	0
30	Slate clay.....	40	0
31	Sandstone irregularly stratified.....	80	0
32	Clay stone, with impressions.....	1	0
33	Fire-clay.....	0	6
34	COAL.....	0	4
35	Black slate.....	1	0
36	Grey sandstone.....	3	0
37	Hard claystone, with vegetable impressions of rushes, &c.	4	6
38	Fire-clay.....	2	6
39	{ Slaty COAL Fire-clay Solid COAL Slaty COAL }	4	5
40	Black slate.....	1	6
41	Slaty sandstone, hard.....	2	0
42	Slate clay	10	0
43	Slaty sandstone, thin beds	20	0
44	Grey sandstone.....	20	0
45	Slaty sandstone	18	0
46	Black slate clay.....	100	0
47	Slaty sandstone, with thin alternating beds of slate clay.....	160	0
48	Coarsegrained slate-clay, sometimes passing into slaty sandstone.....	200	0
49	Indurated claystone passing into sandstone..	2	6
50	Fire-clay.....	2	0
51	{ Soft COAL, slaty...1F. 6l. } { Solid COAL.....1 6 }	3	0

No.		Feet.	Inches.
52	Hard grey sandstone; this bed usually covers the coal, but in some places there is a bed of slate clay from one to four feet thick between it and the coal.....	18	0
53	COAL.....	0	1
54	Coarsegrained grey sandstone, frequently containing fragments of slaty sandstone and black slate clay.....	36	0
55	Slaty sandstone.....	40	0
56	Fire-clay.....	3	0
57	COAL.....	0	9
58	Black slate clay.....	25	0
59	Slaty sandstone.....	8	0
60	Blue slate clay.....	5	0
61	Grey sandstone.....	10	0
62	Blue slate clay.....	12	0
63	Slaty sandstone.....	10	0
64	Grey sandstone.....	12	0
65	Blue slate clay.....	8	0
66	Slaty sandstone.....	9	0
67	Black slate.....	8	0
68	Slaty sandstone.....	1	6
69	Black slate.....	3	0
70	FOUR FOOT COAL.....	4	0
71	Slaty coal or kelve.....	2	0
72	Black slate clay with ironstone.....	15	0
73	Grey slaty sandstone.....	16	0
74	Blue slate clay.....	6	6
75	Blue slaty sandstone.....	8	0
76	Grey sandstone	14	6
77	Blue slate clay.....	26	6
78	Hard grey sandstone.....	11	0
79	Blue slate clay.....	20	0
80	Grey slaty sandstone	18	0
81	Fire-clay, or coal seat.....	2	0
82	Drummagh foot COAL.....	1	0
83	Black slate clay, with balls of clay ironstone	13	0
84	Grey slaty sandstone.....	34	0
85	Blue slate clay.....	4	0
86	Grey sandstone.....	35	0
87	Fire-clay	0	6
88	COAL	0	2
89	Black slate clay, with clay ironstone beds...	25	0
90	Grey sandstone.....	4	0
91	Blue slate clay.....	3	0

No.		Feet.	Inches.
92	Grey sandstone.....	6	0
93	Seat rock, or sandstone, containing vegetable impressions.....	3	0
94	Fire-clay or coal seat.....	4	0
95	First bed of THREE FOOT COAL.....	3	3
96	Black slate clay with ironstone, containing muscle shells.....	36	0
97	Micaceous slaty sandstone.....	22	0
98	Grey sandstone slightly calcareous.....	15	0
99	Blue slate clay.....	3	0
100	Grey sandstone slightly calcareous.....	12	0
101	Grey slaty sandstone.....	9	0
102	Grey sandstone.....	1	0
103	Blue slate clay.....	1	6
104	Grey sandstone.....	1	0
105	Grey slaty sandstone.....	6	0
106	Hard blue slate clay, with ironstone.....	4	0
107	Sandstone with vegetable impressions (seat rock).....	3	4
108	Fire-clay, or <i>coal seat</i>	1	0
109	COAL 1 0 Fireclay 1 6 COAL 1 0 Double seam	3	6
110	Blue slate clay with vegetable impressions of ferns, and small nodules of clay ironstone.....	17	10
111	Fire-clay, or <i>coal seat</i>	3	0
112	Upper bed of THREE FOOT COAL.....	3	0
113	Black slate clay.....	6	4
114	Clay ironstone.....	0	1
115	Blue slate clay.....	9	0
116	Clay iron stone.....	0	2
117	Black slate clay.....	3	0
118	Clay ironstone.....	0	2
119	Blue slate clay.....	22	0
Total height above the granite.....		5246	7

DETAILED DESCRIPTION OF THE REMARKABLE
BEDS WHICH OCCUR IN THE LEINSTER COAL
DISTRICT.

No. 1. Limestone. The substance has already been described.

No. 2. Black slate clay. This substance has been observed to rest upon the limestone in every situation where the coal and calcareous strata were found in contact. In many places the lower beds resemble flinty slate, but as they ascend, or as they are further removed from the limestone, the flinty slate passes gradually into black slate clay. Balls of clay ironstone are frequently met with in the upper beds of black slate clay.

This rock is of various thickness in different places. In the wood of Clogrennan, two miles south-west of Carlow, a pit was sunk, and bored through 100 feet of this black slate clay, in search of coal, without reaching the limestone. At Spring-hill it exceeds 300 feet. At Old Leighlin it is about 80 feet; and further south it is frequently less than 30 feet thick. This bed is generally so very black and carbonaceous, that in many places where borings have been made through it in search of coal, the borers judging from the black colour of the

water, which issued from the borehole, have declared that they found coal. But wherever pits have been sunk in consequence, nothing was met with but black carbonaceous slate-clay. A tradition is still prevalent in the country that coal was found at Old Leighlin, and in other places where borings have been made many years ago through this black slate-clay, but that the borers were bribed to say there was none. Less detail would have been requisite respecting this bed of black slate-clay, had the fruitless trials already made been sufficient to prevent further sinkings and borings: But country gentlemen attend so little to these matters, and are so frequently imposed on by crafty colliers, (who being too idle to work at the great collieries, are anxious to get well paid for sinking small pits;) that it has been deemed necessary to call their attention more particularly to this bed.

The black slate clay is covered by alternating beds of sandstone and slaty sandstone, (No. 3.) In the line of section, and to the north of it, these beds are from 25 to 50 feet in thickness, but to the south they encrease immensely, and apparently in an equal proportion to the thinning of the slate-clay. At Old Leighlin, Shanakill, Kellymount, &c. where the great flag quarries are situated, these alternating beds are 300 feet in thickness, and amongst them every variety of flag, from coarse to fine grained, and from thick to very thin, may be found. The thickening of

the sand-stone and slaty sand-stone strata, to the south of the district, is not confined to this particular instance; for as far as the undulations in the strata permitted particular beds to be traced, it was invariably found that all the sandstones increase in thickness as they proceed southward; and that the slate-clay diminish in equal proportion; and therefore, in speaking of the general character of the district, it may be said, that to the north of the river Dinan, coal and slate clay predominate; and to the south, sandstone and slaty sandstone: and also where the slate clay and coal are found, the stratification is regular and has a uniform inclination; but where sandstone predominates, the stratification undulates and varies in a few yards, from horizontal to vertical. This irregularity in the sandstone is not entirely confined to the south of the Dinan; for in the midst of the coal fields, undulating beds of sandstone rise up from beneath the coal, and form steep hills, at whose base the coal is thrown up to the surface, and terminates.

In the beds No. 4, 5, 6, and 7, there is nothing remarkable.

No. 8. Spheroidal slate clay, containing balls of clay ironstone, frequently one foot in thickness. By spheroidal slate clay, is meant a species of hard slate, which on being exposed to the atmosphere, divides into large flattened spheroids, on being struck the outer coat comes off,

and leaves a smaller spheroid, which being again struck, a second concentric coat is separated, and so on till the nucleus is met with, which sometimes is composed of hard clay stone, and sometimes of clay ironstone. The ironstone contained in this bed is very rich, and in many places remains of ancient excavations are still visible where this bed has been wrought in search of ironstone; and indeed some of the iron furnaces * may yet be seen.

There is nothing remarkable in No. 9.

No. 10. *Simple carbonaceous or uninflamable coal*, in very thin laminæ, between flakes of black slate clay, and fire clay. This bed is only remarkable from its being the first in which coal occurs. Many trials have been made on it in different places, but none were found worth following, owing to the great admixture of slate and fire clay.

Nothing worth describing occurs between the beds No. 10 and 29.

No. 21. Calcareous fire clay, containing impressions of the *cornu ammonis*, four inches thick. This bed is particularised, merely from its being the only one in which marine shells were found, if we except the occurrence of impressions of muscle shells in balls of clay iron-

* In Killeslin Glen, in examining the remains of a small blast furnace, which has been of a square form instead of the usual circular one, I found some small pieces of cast iron, of excellent quality, amongst a heap of slag.

stone, which have been met with, though very rarely, in some of the uppermost beds of slate clay.

No. 25. Very hard clayey sandstone, containing impressions of rushes. This species of rock, and fire clay which rests upon it, occur immediately below all the regular beds of coal (except the four foot coal,) which occurs in the district. It is called seat rock, and the fire-clay seat clay, or coal seat. The impressions of rushes they contain are never found in the other rocks.

No. 26. Uninflammable coal, or mineral charcoal. This bed of coal varies in thickness from 10 to 16 inches. It may be said to be the first bed of coal which occurs above the limestone: for the slaty substance already mentioned hardly deserves the name. This bed of coal, which in future may be distinguished by the name of *the Rossmore foot coal*, from its having been first worked on Rossmore-Hill, is composed of two distinct substances; conchoidal or solid coal, which occupies the upper part of the bed, and is generally from six to eight inches in thickness, and soft slaty coal, called *kelve* by the colliers. The colour of this coal when fresh broken, is brownish grey with a reddish hue: when exposed to the air, it becomes reddish brown. Its fracture is conchoidal in every direction. It is usually quite free from sulphur, and when burned it leaves about 10 per cent.

of white ashes. Being the lowest, it is consequently of greater extent than any of the beds of coal that cover it. In tracing *the rushes bed of coal*, No. 39, which lays 250 feet above it, the Rossmore coal was also traced from Wolf-hill, on the north of the district, to Uskerty-wood, on the river Dinan, a distance of above 12 miles, and in this great extent the only material interruption in the continuity of the bed, is in the deep valley to the east of Turra-hill, through which the new colliery road from Carlow to Castlecomer has been made. The winding course of the outer edge of this bed of coal is not marked on the map as it might create confusion, but it runs nearly parallel to the outgoing of the first bed of slate-coal. The outgoing of this coal is almost in every instance on the face of a precipitous hill, and the dip is nearly at right angles to the declivity. This unfavourable circumstance has been sufficient to prevent many trials being made to work it. The most expensive attempt was undertaken by the grandfather of Mr. Hamilton, of Sheep-hill, in the county of Dublin. At his cost, a level of considerable length (now nearly closed up) was driven into Rossmore-hill to unwater the colliery, but when workings were attempted to be made on the coal, it proved to be but one foot thick, and could not be wrought to profit. Pits were also sunk many years ago in this coal in the valley below Ardalegle colliery near the line of the

new Carlow road. And five years since Col. Rochfort of Clogrennan, in sinking a trial pit in search of coal, to the east of Clogrennan colliery, discovered this bed; but the strata sunk through in the pit were so much disturbed and broken, that he did not make any workings on it. These are the only trials worth noticing, that have been made on the Rossmore foot coal.

The next remarkable bed represented in the section is composed of sandstone irregularly stratified 80 feet thick. No. 31. This bed, or rather number of beds, is not only irregular in its stratification, but also in its thickness and composition. It frequently passes from sandstone into slaty sandstone, and even into alternating beds of sandstone and slate clay. Its thickness varies from 60 to 140 feet; it is also very irregular in respect to its distance from Rushes bed of coal which lays above it. In the line of section it is only 12 feet below it. At Clogrennan colliery it is 40 feet. This bed, though changeable in its constituent parts, is more frequently composed of sandstone of a greenish grey colour than of any other substance. It is rarely stratified horizontally or regularly, for any considerable distance; it constantly undulates; and when it happens to be the uppermost rock, it forms steep but irregular hills; one of the most remarkable instances of this kind is at Hunt's Park near Clogrennan colliery. Its appearance at this place is repre-

sented in section No. 4. It dips suddenly under the coal, forming a short curve, rises from beneath it again, at an angle of 60° from the horizon, and becomes the surface rock. It there forms a great undulation, half a mile in length, across the lands of Hunt's Park, and again descending, is once more covered by the coal. From Hunt's Park this sandstone may be traced in a western direction along the bed of the river Dinan, forming similar undulations, and when near the surface, interrupting the continuity of the coal, but particularly about Coon Bridge and below the wood of Uskerty. This great sandstone is divided into many irregular beds, but their number varies; I have counted 40, 50, and even 60. The texture is generally coarse grained, the colour of the upper beds is greenish grey, the lower ones are frequently smoke grey and yellowish grey, and are interstratified with beds of slaty sandstone and slate clay; and in some instances, as I have already mentioned, these rocks predominate. When this happens, the inclination of the strata is more uniform. This sandstone forms the most remarkable feature in those parts of the coal district, through which it can be traced, and from its proximity to the Rushes bed of coal, it serves as an excellent guide to lead to the discovery of its outgoing. Beds of coal are very rarely visible at the surface; they may sometimes be traced by the blackness of

the soil, near their edge, but the most certain indication is the discovery of a bed of fireclay, or of sandy claystone with vegetable impressions called seat rock, which lays immediately below the coal; but when these beds happen to be covered with soil, the next resource is in some remarkable bed of rock, such as the sandstone above described, which occurs a few yards above or below the coal.

The beds between 31 and 39 exhibit nothing peculiar either in their appearances or composition. The thin bed of coal No. 34, is of no other consequence than as a proof of the identity of the Rushes bed of coal in different parts of the district, when the other accompanying beds have varied in their thickness and composition; and this leads to a general observation which I have made in this district, but which I believe is not peculiar to it, that the different beds of coal are much more regular, and differ less in quality and thickness, than any of the accompanying strata.

FIRST BED OF SLATE COAL OR RUSHES COAL.

Without its being known to be the same bed, this coal has been discovered and partially worked in several places for many years; but by the assistance of the thin bed of coal, No. 34, and

the great bed of sandstone which lays below it, I have identified it at the different collieries, and have traced its outward edge for ten miles through a part of the country, where no coal had before been discovered or supposed to exist. To avoid tedious description I beg to refer to the map, for the line of the outgoing of this bed of coal. The different places in which it has been worked are Wolf Hill, Ballylihan, Corgie, the Rushes, Moira, Courlean, Clogrennan Hill, and Agharue; excepting Moira, Clogrennan Hill and Agharue, these several collieries are situated on the summits of the hills which form the outward boundary of the district; and the coal dips from the summit inward toward the interior of the district. In most places the dip is much quicker than the fall of the surface, and consequently at a very short distance from the outer edge, the coal becomes inaccessible, from the impossibility of freeing it from water. The Wolf Hill and Clogrennan collieries are the only ones at present at work. The former is unwatered by a level which has been driven at a considerable expence into the hill; but the field of coal commanded by it is trifling. Ballylihan colliery has been idle for many years; the coal has only been worked where it was shallow, the deep part remains untouched. The Corgie, Paulitien, and Rushes collieries are in the same situation. The Grand Canal Company drove a level some years

ago to unwater part of Corguee and the Rushes collieries, but as yet no use has been made of it. The deepest pit ever sunk in the Rushes colliery is 32 yards, and the whole of the water was pulled to the surface. Immediately to the south of the collieries of Paulitien and Corguee, that is to the dip, there is a deep valley, in which the strata appear to be much dislocated and broken. Between the collieries of Corguee and the Rushes, there is a great clay dyke running nearly north and south. It cuts the coal, but does not appear to have disturbed its horizontal position. The exact position of this bed of coal at Courlean colliery, situated to the north of Killeshin Glen, may be seen by reference to the section, No. 2. which runs through the centre of it. Very little has ever been accomplished at this place. Two pits were sunk, and the coal found is reported to have been good, but no workings of any extent were made. Between the collieries of Courlean and the Rushes there is a deep valley, across which, owing to a great clay covering, it was impossible to trace the coal, or to ascertain whether or not it is thrown out by the sandstone undulation which forms Turra Hill. But the outgoings of this coal were traced in a western direction from the pits at Courlean to the head of Killeshin Glen, and from thence along the summit of Rossmore Hill, and the head of Glasha Glen to Colonel Rochfort's colliery at Clogren-

nan Hill. Owing to the peculiar situation of the coal it will be almost impossible to work any part of it from the head of Killeshin glen to the new Carlow road, as it crops out on the face of the precipice, and dips directly into the hill. Between Killeshin glen and Clogrennan colliery it lies near the summit of the hill, but unfortunately the coal is but 16 inches thick : this was ascertained by two pits sunk in it many years since, which were abandoned in consequence; for none but those well skilled in the management of collieries, are likely to succeed in working a bed of coal of that thickness.

The colliery at Clogrennan has been working many years, but on a very small scale. The first discovery of the coal was near the southern edge in the insulated hill represented in section No. 4. In this place the bed was from 14 to 16 inches thick, and the quality so bad that it hardly paid the expence of raising. Other pits were subsequently sunk to the north of the first, and though the quality of the coal was better, still owing to the encreased depth of the pits, the expence exceeded its value. After ascertaining, last summer, that the Clogrennan coal was a continuation of the first bed of slate coal, a borehole was made, considerably to the north of the old workings, to prove the thickness of the coal; for when the beds were traced, and *the angle and direction of their dip* determined, it was easy not only to foretel with confi-

dence that the coal was there, but also with tolerable accuracy the depth at which it lay. Contrary to the expectation of the colliers the event proved that I was right. Having discovered the coal by boring, it was recommended that a pit should be sunk still further north, in a situation where by calculation it was ascertained that the depth of the coal below the surface would be but *nine yards*. When sunk, the coal proved to be much superior in quality to that formerly worked, though the depth from the surface in the old pits was 20 yards and upwards. It usually happens that beds of coal are compact in proportion to their depth below the surface, at least till they arrive at the depth of 40 or 50 yards. The anomaly in the present case may be accounted for by the disturbance created near the southern extremity of the bed of coal, by the undulation of the sandstone, as represented in section No. 4.

From Clogrennan colliery to the north of the sandstone undulation, the coal dips toward the lands of Hunt's Park at a considerable angle; but in the hill of Ardough the strata change their inclination and rise with it.

In the stream which forms the boundary of the counties of Kilkenny and Queen County, to the west of Hunt's Park, the outgoing of the coal may be seen in many places very near the surface. It is therefore probable that a considerable field of the coal will be found at no great

depth in Hunt's Park. Between the County of Kilkenny boundary and Clogrennan colliery, as appears from the map, the outer edge of this bed of coal has been traced for a great distance in the county of Kilkenny, both to the north and south of the river Dinan. No trials have hitherto been made on the north side, but on the south at Agharue, Sir Richard Butler, Bart. sunk some pits, close to the road between Castlecomer colliery and Leighlin Bridge. These pits were sunk in the worst possible situation, close to the crop of the coal, and though a water level might have been carried along the coal, from the outgoing on the face of the precipice near the river Dinan to the pits, it was never attempted; but the whole water of the colliery, which was very considerable, was drawn up by manual labour through the pits to the surface. The coal was so bad, and the water so expensive to raise, that this colliery was soon abandoned. Had the pits been sunk further to the north east, and a proper level been driven to carry off the water, Agharue colliery might possibly have been made to answer. In the lands of Raheen, immediately opposite Uskerty wood, the first bed of slate coal has been discovered cropping out in two or three places on the face of the hill, and at the regular distance below it the Rossmore foot coal already mentioned has also been traced. Some pits have been sunk a little to the dip on the first bed of slate coal,

and six inches of solid coal, and thirty inches of slaty coal, or kelves, are said to have been found.

Owing to the thick covering of limestone gravel, it was impossible to trace this coal on the south side of the Dinan for any considerable distance, but from the occurrence of the great sandstone bed, and from finding large blocks of *seat rock* in two of the streams of Damerstown, it is probable that a thin bed of coal extends through both upper and lower Damerstown, but at what depths it is not possible to ascertain without sinking or boring.

When the first bed of slate coal had been traced nearly without interruption, from Wolf Hill in the Queen's County to Uskerty wood in the County of Kilkenny, I entertained sanguine expectations of being able to complete the circuit; but on crossing the Deehan river, these expectations were not fulfilled, at least not satisfactorily so, for stream after stream and precipice after precipice were examined, without discovering either coal, seat clay, seat rock, or even the great sandstone. *

* Since this report was written I have again visited Castle-comer, and in attempting to trace the first bed of slate coal to the north of Eskerty wood, I discovered a number of beds of sandstone in the glen of the rock of Foyle, which I believe to be the sandstone already mentioned that lies below the first bed of slate-coal; and though I did not find the coal itself, I am persuaded it is there, for at the regular distance below the sandstone strata I found a ten inch bed of coal resembling the Rossmore foot coal.

At Ballyhemmin, half a mile below Castlecomer, a thin bed of coal makes its appearance in a stream, close to the road side. The fire clay and seat rock are very thick, but the stratification is so much disturbed and broken, that it was impossible to determine with certainty whether this bed of coal is, or is not, a continuation of the first bed of slate coal.

It would be useless as well as endless to describe all the places that were fruitlessly examined in that part of the circumference of the circle between Ballyhemmin and Wolf Hill. I shall conclude my observations on this bed of coal, by stating my full persuasion that it was originally deposited complete within the whole circle, though possibly not of equal thickness and quality throughout, but that the undulations and dislocations that have subsequently taken place over the whole coal district, and which are more than usually numerous to the west of the river Deehan, have so far interrupted the continuity of this bed, as to render it impossible to trace it accurately between Ballyhemmin and Wolf Hill.

If we examine the western extremity of the great section of the district, Plate No. 2. the two beds of coal that occur in the lands of Moyhora, appear in a certain degree to correspond with the first bed of slate coal, and the Rossmore foot coal below it, but their characters without further proof are not sufficiently similar

to carry conviction as to their identity. Beds similar to those of Moyhora have been discovered at Crut to the north of it; but between this last place and Wolf Hill nothing was discovered except some beds of soft culm, which appear in the ditches to the west of Chatsworth; and owing to the thick clay covering, no section either above or below them could be seen. The first bed of slate coal dips on all sides from the edge toward the interior of the coal district. We may therefore conclude that it extends, without interruption, from one side of the district to the other.

In describing the different situations where the first bed of slate coal has been worked, the Moira colliery was mentioned. This colliery is situated a mile to the south of Wolf Hill, as will appear by referring to the map, and nearly in the direction of the dip of the strata at that colliery. It might therefore be supposed that the coal would be found extremely deep at such a distance to the dip; but this is not the case, owing to its being thrown up nearly to the surface by the sandstone undulation of Drimsallagh Hill, in a manner similar to that represented in section No. 4. This colliery was discovered a few years ago, and three pits were sunk to the coal by the Grand Canal Company, on one of which a steam engine was erected to draw the water; however the colliery was soon abandoned, and the steam engine removed.

The first bed of slate coal is usually composed of three distinct varieties of coal, namely, solid coal which lies at the top, eighteen inches in thickness; culm or soft coal three inches; and kelves or coal mixed with slate fifteen inches, making altogether three feet between roof and floor. The solid part has a tendency to break in rhomboidal forms, and when long exposed to the weather the rhombs divide into flakes from one to three inches in thickness. The fracture of the coal in the direction of the stratification is slaty, but the cross fracture is conchoidal. The solid part of the coal is usually free from sulphur, and when newly raised makes an excellent fire. An average specimen of it was found to be composed of 92 per cent. of pure carbon, and 8 per cent. of ashes.

The coal at Corguee, Paulitien, Ballylihan, and Moira, are nearly similar to the Rushes. It is not so thick at Wolf Hill. At the head of Killeslin glen the solid coal is but twelve inches thick, below it there are three inches of kelve, then seat clay from one foot six inches, to two feet, and afterward eight or nine inches of slaty kelves. The coal at Clogrennan colliery is similar to that at the head of Killeslin glen.

We shall now proceed with the detail of the section.

The second bed of slate coal is covered in the line of the great section, No. 2. and at most of the collieries, by a bed of black slate clay, which is succeeded by slaty sandstone, and

this rock by slate clay. In the southern extremity of the Rushes colliery, a bed of grey sandstone ten feet thick lies above the coal, but to the north, this bed gradually disappears. At Paulitien colliery, twenty-three feet above the coal, there is a bed of flinty slate, similar to that which occurs immediately above the limestone already described, which varies in thickness from seven, to twenty feet. But the sections of the alternating strata, that occur in different collieries, will be found under the proper head in the Appendix.*

When this coal is covered by soft black slate clay, the mode of working that I should recommend is that called the *broad way*, which is described in the concluding article of this report. At my suggestion this method has been put in practice with success at Clogrennan colliery.

The system of working that has been adopted at Corguee and the Rushes collieries is represented in Fig. 1. Plate No. 5, in the *Hurrying roads*,

* I have carefully collected the journals of the different rocks that have been sunk, or bored through in the numerous trials that have been made of late years, in the Leinster coal district. They are numbered and marked on the map in their proper situations. By this means any future investigator will be enabled to ascertain without any difficulty what trials have been made, and draw his conclusion accordingly. Many of these documents are in the hands of common miners, at whose death they would have been lost, but the greater number were copied from books belonging to Mr. Aher, the manager of the Castlecomer colliery.

which run diagonally across the workings; part of the slate roof is taken down, to make a greater height of head-way. The plan of working, as represented in the plate, has some merit, but no air courses are preserved, and consequently it becomes necessary to sink pits very close to each other; they are rarely more distant than thirty or forty yards. The detail of drawing the coal under ground is similar in this and in all the collieries of the district; and as I shall enter minutely into that subject, when treating of the present mode of working the first bed of three foot coal, I need not enlarge upon it at present.

SECOND BED OF SLATE COAL, OR TOLLERTON COAL.

The strata which intervene between this bed of coal and the first bed of slate coal, are composed of alternating beds of sandstone, slaty sandstone, and slate clay; as may be seen by referring to the table, or to section No. 2. The coal itself is very similar to the first bed of slate coal, but it is harder, and breaks rather into cubical than rhomboidal fragments: it is also accompanied by kelves or soft slaty coal. The solid coal varies from eighteen to twenty-four inches in thickness, and the soft, from twelve to eighteen inches. Sometimes the upper part of the solid coal has a fibrous texture, and when

exposed to the air divides into plates of an inch in thickness; this is called kennel. But this fibrous species rarely exceeds four inches in thickness.

The second bed of slate coal has not been discovered or worked in as many places as the first. The principal collieries are the Tollerton and Ardategle on the east side of the district, and Firoda on the west. This bed of coal is apparently lost to the north of Tollerton, in the valley through which the new Carlow road has been made, in the same manner as the first bed of slate coal; to the south it has been traced for a considerable distance through the colliery of Ardategle. Between this point and the river Deehan, the face of the country is covered to a vast depth by clay, which has prevented the accidental discovery of the outgoings of this coal to the south west of Ardategle, and no trials have ever been made; but there can be no doubt of the existence of the coal in that line. In fact the discovery of the outgoings of the first bed of slate-coal which lies below it may be considered as a sufficient proof.

The undulations and disturbances that have taken place in the strata to the west of Deehan, have been already mentioned, and if we except Firoda, no workable bed of coal appears to exist. Great difficulty arises in proving that the Firoda coal belongs to the second bed of slate coal. If the coal which lies below it belongs to

the first bed, the doubt is removed, but it has been already shewn that it is impossible to ascertain this; the coal itself, though similar in thickness, is purer in quality, and not so hard; besides it contains no kelves, but the strata which cover it are similar, and the coal roof in both, is composed of sandstone, excepting where the coal is near the surface, and then it is found to be black slate-clay; but this change also takes place under similar circumstances at Tolerton and Ardategle.

Owing to frequent undulations in the strata, the coal field at Firoda is exceedingly irregular; and the dip of the coal varies so much in direction and steepness, that it is almost impossible to work the colliery with any degree of regularity. In Section No. 5, Plate No. 4, the position of the coal in a north-east and south-west direction is shewn. These frequent changes render the task of discovering the extent of this coal exceedingly difficult. But it is probable that the Firoda coal is very extensive both to the east and north. In an eastern direction it dips under the town of Castlecomer, and in a northern, having followed the undulations represented in the section, it probably extends towards Crut. The Firoda coal appears to extend considerably to the westward of the present workings, but not to the north. If this were not evident from the coal being worked out to the surface in that direction, the fact

would have been incontestably proved by a deep borehole made lately, very unadvisedly, to the north of the outgoing of the coal, and to the rise of the strata.*

In the Tollerton and Ardategle collieries, though considerable workings have been made, and pits innumerable sunk, no coal except that which lies near the surface has been worked; and the best and most solid part still remains untouched: but owing to the accumulation of water it cannot be worked without a steam engine, or by taking up a deep level from the side of the hill.

The undulations in the bed of coal at Firoda colliery, render it more difficult to work to advantage than any bed in the district; but unfortunately at this place less judgment has been displayed than at any other coal work. A very considerable extent of this bed has been wrought, but no profit has been made, owing to the unnecessary number of expensive pits that have

* When first I visited Firoda colliery, this borehole was proceeding in full vigour, and at a very considerable expence. On learning its object it required but little argument to prove to the borers themselves that they were boring beyond the edge of the coal and to the rise of the strata, and consequently were sinking through rocks that lie beneath the coal. In my capacity as a public officer I thought it my duty to inform the agent of the estate (for the Proprietor resides in England) that the boring should be discontinued, as not likely to lead to any beneficial result.

been sunk, many of which are twenty-six yards in depth.

The second bed of slate-coal being very similar in its nature, and similarly circumstanced with the first, the broad method of working would be the most economical that could be applied to it. Indeed the mode that has been practised at Tollerton and Ardategle, though conducted in a slovenly manner, is less to be objected to than perhaps any other in the country. Having drifted on a level on either side from the pit, the colliers work to the rise, seven men abreast, each man occupying three yards, altogether twenty-one yards. But as no air courses are preserved, according to the general custom of the country, pits are sunk very close to each other. See Plan, Plate No. 5, Fig. 2. The practical part of drawing out the coal is exactly similar to that practised in working the first bed of three foot coal, and will there be described.

The second bed of slate coal is generally covered by a bed of grey sandstone 18 feet thick; this is succeeded by a thin bed of coal 2 inches thick; next is a second bed of sandstone which contains fragments of slate clay 36 feet thick, and then slaty sandstone 36 feet; these several strata have been sunk through in the different pits at the Ardategle and Tollerton collieries. Owing to the great thickness of clay covering it was impossible to ascertain with any degree

of accuracy the outgoings of the different beds which lie above the slaty sandstone of Tollerton colliery and that met with at the bottom of the borehole No. 26, near Drummagh colliery, an height of 190 feet; the beds that are drawn in the section No. 2, between those points, are not placed there from actual observation on the spot, but from borings made at Mass Ford, and to the west of that colliery, where some of the same beds of coal occur that are met with on the east side of the coal bason. From these data, and also from borings made at Monteen colliery, and to the south of it, I am of opinion that a bed of coal, nine inches in thickness, occurs in the series at the height of 110 feet above the second bed of slate-coal, as marked in the section. This bed of coal has been discovered in many places, particularly to the east of Kilgorey, to the south of Monteen and Ahamucky collieries, at Loon orchard and other places south of Massford.

The next bed of importance in the series is the

FOUR FOOT COAL.

This stratum has now been discovered in six different places. By calculation it appears to be 115 feet above the nine inch coal just mentioned, but its extent or the general line of its

outgoing has not yet been fully determined. This bed of coal was first discovered, and three pits were sunk on it at Geneva colliery, in the year 1796 or 1797; it was then supposed to form a part of the first bed of three foot coal, which will be described in its proper place, but which lies at least 240 feet above it. The Geneva colliery was soon abandoned, owing to the great quantity of sulphur pyrites contained in the coal. In the year 1805, the four foot coal was bored to at Kilgorey, by the Grand Canal Company, but no pits were sunk. Their agents supposed it also to belong to the first bed of three foot coal. In the year 1809 it was discovered in the glen of Ahamucky, by Mr. Aher, manager of the Castlecomer colliery, who first observed that it possessed characters essentially different from the first bed of three foot coal, and besides that there was no fire-clay or coal-seat below it. Mr. Aher afterward sunk some pits on this coal at Monteen colliery, and lastly he caused two deep boreholes to be made below the seat-rock of the first bed of three foot coal, and at the depth of 214 feet at borehole No. 20, and 248 feet at borehole No. 21, at Massford he discovered the four foot coal. In these boreholes the coal appears to be thicker and more solid than in any of the other trials. The upper part of the bed is composed of five feet five inches of slaty coal or kelves, under which is three feet of hard coal containing some sulphur

pyrites, then a bed of black slate-clay of six inches thick, and lastly one foot of coal containing a thin bed of kelve near the bottom, making altogether a height of coal-kelve and slate of ten feet, of which but four feet are solid coal.

At Ahamucky the thickness of the kelve or slaty coal is but 1 foot 6 inches, which is succeeded by black slate-clay and pyrites, and lastly very hard coal containing some bands of pyrites 3 feet.

At Monteen colliery the thickness of the kelve is 2 feet 4 inches, and of the coal 4 feet. After much consideration and comparison of the strata in the different pits and borings, in which I received great assistance from Mr. Aher, I was enabled to determine with reasonable certainty, that the four foot bed of coal occurs on an average at the depth of 80 yards below the first bed of three foot coal. Owing however to the increasing thickness of some of the sandstone beds, the depth varies considerably, particularly at the top of Coolbane-hill, where a borehole has been made in search of the coal; more than 80 yards have already been bored beneath the three foot coal, and the sandstone bed which in other borings lies above the black slate-clay which forms the roof of the coal, has not yet been penetrated.

From the different positions in which this bed of coal has been discovered, it appears that there exists at least 5000 acres of it in the district, the

greater part of which, as it lies beneath the first bed of three foot coal, will be found at the depth of from 100 to 140 yards.

None of the places at which the four foot coal has been discovered, except borehole No. 21, at Massford, happened to be in the line of the great section No. 2, and consequently the position which this bed of coal occupies in the section has been determined by calculating the distance at which it lies, beneath the first bed of three foot coal. It is probable that at the expiration of three or four years the whole of the first bed of three foot coal, which has hitherto supplied the market with hard coal, will be consumed, and if it were not for the discovery of the four foot coal, no resource would have been left, excepting the first and second beds of slate-coal; but the coal of these beds is of such a soft and tender nature that it will not bear long carriage, and therefore could not have answered as a substitute for the present hard Kilkenny coal. The four foot coal is closer in its grain and much harder than the coal hitherto known by the name of Kilkenny coal. Its specific gravity is 1.591. Upon analysis it was found to be composed of 96.25 per cent. of carbon and 3.75 per cent. of dark grey ashes. Owing to its great depth this bed of coal must be worked according to a regular and scientific plan. The narrow way of working, as represented in the plate at the conclusion of this report, is the best

that can be followed, and by this means one pit will be sufficient for an extensive colliery, and the increased depth of the coal will be of no material consequence. I have already mentioned that this bed of coal is composed of a stratum of slaty-coal or kelve at the top, then a bed of black soft slate, and lastly four feet of solid hard coal; at least this is the general arrangement. The plan of breaking down the coal, which I should recommend, is to commence by working out the bed of soft slate and throwing it aside, next to wedge down the kelve, and lastly to wedge out the solid coal. By this plan it will not be requisite to cut the solid coal, excepting at the sides next the pillars. This is material, as owing to its extreme hardness, the holeing in the coal, either at the bottom or top, would be a most tedious and expensive operation.

The kelve or slaty-coal will answer extremely well for burning lime, and the solid coal, when properly separated from the bands of sulphur, pyrites will be found nearly equal in quality to the hard coal at present sold. The bands of pyrites need not however be rejected as useless, for by proper management they may, at a trifling expense, be converted into sulphat of iron, (the common copperas of commerce.)

The four foot coal is covered by alternations of black slate-clay and clay-ironstone, forming a succession of beds of 15 feet. They are succeeded by beds of sandstone and slaty sand-

stone, in which there is nothing remarkable; indeed the only bed worth mentioning which occurs in the strata immediately above the four foot coal is a hard siliceous stratum three feet in thickness. The colour of the rock is dark smoke grey; its lustre is dull, and fracture earthy. It contains numerous calcareous impressions of muscle shells, but the calcareous matter is confined to the shells alone, none being contained in the mass of the rock. This bed occurs generally at the height of 34 yards above the coal.

THE FIFTH BED OF COAL; OR THE FOOT COAL,

No. 85.

This bed of coal is usually met with 40 yards above the four foot coal, and also 40 yards under the first bed of three foot coal. It varies in thickness from eight inches to one foot. It occurs only in the centre of the mineral bason, where the covering of clay on an average is 36 feet thick. On this account its outgoing has been discovered in very few places, but the coal has been sunk and bored to in more than one hundred places. These borings and sinkings were not however made in search of it, but generally in expectation of finding the first bed of three foot coal. A great number of these borings are marked on the map, and the proximity of many of them to the outgo-

ing of the three foot coal is remarkable. This bed was attempted to be worked many years ago at Drummagh, where it occurs near the surface, but nothing worth mentioning was accomplished.

There is nothing remarkable in the strata which intervene between the Drummagh foot coal, and the fire or seat-clay, beneath the first bed of three foot coal. This bed of fire clay is of very fine quality, and is in my opinion superior to that of Stour-Bridge in Worcestershire, already mentioned. Excellent fire bricks have been made with it, but no manufacture to any extent has been attempted.

According to Mr. Tighe, this substance is composed of 54 per cent. of silex and 44 of argill, * but from my own experiments, the ingredients and their proportions vary in different beds.

THE SIXTH BED OF COAL, OR THE FIRST BED OF THREE FOOT COAL.

This bed of coal is of excellent quality, and is infinitely superior to any other that has been discovered in the district. It is generally known by the name of the Kilkenny coal. It was analysed with great care by Kirwan. According to him it contains from 96 to 97 per cent. of pure

* Statistical Survey of the County of Kilkenny, p. 53.

carbon, and from 3 to 4 per cent. of ashes. It is much purer than the carbonaceous coal of South Wales and Scotland. The specific gravity of this coal is 1.526; it is greater than that of any bituminous coal. On this account a horseload of it occupies a smaller compass, but owing to the closeness of its grain, it consumes so slowly that one ton of it will give out more heat, and last much longer than the same weight of any other species of coal. It is extremely hard, and may be carried a great distance over rough roads without breaking in the least. This bed of coal varies in thickness from 2 feet 6 inches to 3 feet 4 inches. The roof, as appears by the section, is composed of black slate-clay, which varies in quality in different places. It is however generally tender, and may be considered on the whole as a bad roof.

The first bed of three foot coal lies 80 yards above the four foot, or newly discovered coal; it has long been considered as the only one of importance in the coal district. Its extent, in comparison with the preceding beds, is very trifling. It lies very irregularly, being formed in small basons, filling up the vallies between the hills; its boundaries were accurately traced with great facility, as unfortunately the greater part of this most valuable bed has been wrought out. The irregular outline of the different basons in which this bed of coal has been found, need not here be described, as they are all

traced on the map. The first bed of three foot coal extends irregularly through part of three great royalties, viz. The royalties of the lordship of Castlecomer and Clogh, which are situated in the county of Kilkenny, and the Doonane royalty in the Queen's County. In these three royalties, three great collieries have been worked; but the most important, and by much the most extensive is the lordship of Castlecomer colliery. This colliery was commenced in the beginning of the last century, by Sir Christopher Wandesford, and has continued at work, almost uninterruptedly, ever since. The first workings were made on the top of Coolbane-hill, where the coal lay near the surface; but afterwards workings were commenced at the base of the hill, where the coal having been thrown down by a slip of 70 yards, as represented in section No. 3. In different situations along the flat at the base of the hill, the colliery has been continued working until the present time. In this royalty from 15 to 20 acres of coal, situated at Massford, two miles above Castlecomer, and a few acres on either side of the Castlecomer road, are the whole that remain unwrought, out of an extent of nearly 3000 acres. This bed of coal has also been worked to a considerable extent in the Doonane royalty, but the old colliery of Doonane has been abandoned since the year 1798. Subsequently, in the year 1803, the Grand Canal Company, (the present lessees

of the royalty) discovered a detached bason of the coal on the lands of Boulavoneen, in extent about 60 acres. This colliery has now been at work seven years, and has lately become very profitable.

In the royalty of Clogh the first bed of three foot coal was discovered many years ago; a steam engine was erected to drain it, and many pits were sunk, but the colliery was soon afterwards abandoned, it is said owing to the badness of the roof.

The system of working that has been followed at these several collieries, is perhaps the most improper and expensive that could have been adopted. The appearance of the surface in every part where the coal has been wrought, bears a strong resemblance to a rabbit warren; there being a continued succession of hillocks and holes. Indeed the number of pits that have been sunk may justly be compared to the perforations in a cullender. It is not wonderful, when the colliery was first commenced by Sir Christopher Wandesford, that the coal was only wrought where it was shallow, and that ignorant colliers found it less troublesome to sink pits every 20 or 30 yards than to support a bad slaty roof, and extend the works farther. But it is to be regretted that in these times, when in England the art of coal working and mining machinery have been brought to the greatest perfection, that the Kilkenny collieries should

have continued without any improvement in the underground workings, for the last hundred years, as the very same system pursued by Sir Christopher Wandesford in the commencement is still persisted in; for even where the coal is 60 or 70 yards deep, the pits are rarely more than 100 yards asunder, and this is quite necessary according to the present slovenly system of carrying on the underground workings. No regular air-courses being preserved, the workings cannot be extended to any considerable distance from the pit, and consequently wherever the air is deficient, a new pit must be sunk.

It would have been extremely difficult, within the last ten years, to have made any material improvement in the mode of working in the colliery of the lordship of Castlecomer, as there were frequently 15 or 20 pits at work, some of which were three miles asunder. This colliery has, during the last 50 years, been managed by a number of successive Irish and English agents, without any improvement being made. The present manager, Mr. Aher, is an Irish gentleman, and a very scientific man. He found it impossible, from the circumstances above stated, to attempt any alteration of the system. Before he was appointed to the management, the colliery was considered as worked out, and the new workings made by him have, for the most part, been on detached patches of coal

that were left or forgotten by former managers, and some trifling basons of coal which he discovered. Mr. Aher is certainly the only person in the country who understands, or has studied its stratification, and I am indebted to him for the details of the numerous borings made in the Castlecomer royalty, which amongst others will be found in the appendix; and also for his assistance in affording me materials for the east and west section of the Castlecomer colliery, plate No. 4.

In order to convey my ideas of the improvements that may be made in working these collieries, it is necessary that I should first describe the system that is followed at present. For the plan of working, I beg to refer to plate No. 5, fig. 3. The pits are there represented as being sunk at the distance of 80 yards; they are supported by four pillars of coal, each six yards square. The first operation is the cutting a passage or air course between the pits; this is called splitting. The general working on the coal is next commenced, and followed on according to the system represented in the plan; the parts left white are the *rooms* or *boards*, which are first excavated; their dimensions are 15 feet long by six broad: between each of the *boards* a pillar of coal six feet by three is left to support the roof; in the centre between the pits a barrier of coal is left as a further support to the roof; when the whole extent to the rise which

the pit can command, has been wrought as represented in the plate, as many of the pillars are cut away as can be removed with safety; but it rarely happens that more than one-third are saved.

When a pit is sunk and ready for work, the agent generally lets it to a *master collier*, who is a species of middle man, between the collier and the agent. The master collier agrees to deliver the coal on the surface for a certain stipulated price, which varies from 6 to 8 shillings a ton, according to the difficulty of the work. This man engages a number of collier's or a *crew*, as they are generally called, to work with him; each man has a particular kind of work allotted to him, and a certain portion is considered as a day's work; a *crew* consists frequently of 50 or 51 persons, who are divided into

	£.	s.	d.
20 Clearers, whose wages per day is 2s. 2d. each	2	3	4
20 Cutters, ditto	2	3	4
6 Breakers, ditto.....	0	13	0
2 Hurriers, ditto.....	0	4	4
3 Thrusters, 1s. 8d. each	0	5	0
Total cost of labour under ground for one day.....	£5	9	0

The work is commenced by the *clearers*, who clear away the slate from the top of the coal ge-

nerally for one yard inward, but that depends on the distance of the next back or natural division in the coal; when the clearer meets one of these, he always stops. The clearer's task is to clear the slate from the top of the coal for a length of from two yards and a half to three yards; he is succeeded by the cutter, whose business is to make a cut or incision in the coal from *roof* to *floor* either a yard inward or to the next *back*; the cutter makes seven cuts for his day's work: last comes the *breaker*, who breaks down the coal by wedges generally driven in at the bottom. When broken down, the coal is put into a wooden box, which holds $3\frac{1}{2}$ hundred weight, placed on a small sledge, and is drawn by the *hurrier* to the pit bottom by means of an iron bar hooked into a ring on the front of the sledge. The *thruster* pushes the box behind. Besides the expense of the labour of the *crew*, the master collier finds horses to raise the coal from the pit bottom to the surface, by means of a horse-gin, and also candles for the use of the workmen under ground.

Objections may be made to this mode of working in almost every stage. The first is the immense sums which the proprietor pays for sinking so many pits, and the consequent expense of watchmen at each pit, to prevent pilage, which even with this precaution is still very great. Secondly, The master collier pays the collier hurriers and thrusters by the day, not

by the quantity wrought, and owing to the slovenly manner in which the coal is worked, the difficulty of dragging it through the passages is so great, that the hurrier and the thruster necessarily receive a greater part of the money than should come to their share if greater regularity were preserved.

In the concluding part of this report, a description of the mode of working collieries on the most improved plan will be found. I need therefore only observe in this place, that the system of working, by master colliers, should be discontinued; that each collier should work for himself; that hurriers should be paid by the ton for drawing the coals to the pit bottom, and should be independant of the collier; that the boards or drifts in the coal should be laid out by the manager, on a regular system, not according to the whim or judgment of the collier; that air-courses should be regularly preserved throughout the workings, which by this means might be much more extensive in each pit than they are at present; that rail-ways should be laid in all the great leading passages throughout the work, and that the hurriers should draw the coals to the pit bottom, in waggon. By this means the thrusters might be discontinued, and in deep and extensive pits the roof should be taken down in the leading passages of the mine, and horses employed instead of men underground, to draw the coals to

the pit bottom, according to the manner described in the concluding article of this report.

I have no doubt that Mr. Aher would have encountered the Herculean labour of attempting to remove the prejudice of the colliers, and have worked Massford colliery on an improved plan, had not all the pits which are requisite to work the colliery according to the old system been sunk long since by a former manager.

I cannot help regretting that the Grand Canal Company should have commenced, and persisted in following the wretched system of the country, in their colliery on the lands of Boulavoneen, now called Newtown. This coal varies from 3 feet to 3 feet 4 inches in thickness, and is solid from top to bottom. The engine pit is 68 yards deep, and the shallow pits, to the rise, are from 25 to 30 yards. (See east and west section of the district.)

This colliery, which originally consisted of about 60 acres of the best coal ever discovered in the Leinster district, has now been working seven years, and many pits have been sunk and wrought out, in which, as is usual, half the pillars have been left behind. Had this colliery been properly commenced, the whole of it might have been worked from the engine pit, enlarged to twice its present dimensions, and divided into three compartments, through two of which coals might have been raised by a winding steam engine, and the water through

the third. There are several much more extensive collieries at Newcastle on Tyne, worked advantageously from one pit, where the coal is nearly at the same depth below the surface as at Newtown, namely between 60 and 70 yards. But at Newcastle horses are used under ground to draw the coals to the pit bottom.

Had this system been originally adopted, the quantity of coals raised per acre would have been much greater than at present. The expence of sinking the numerous pits, the erection of horse gins, and all the apparatus belonging to a pit, would have been saved, as also the whole of the horses at present employed at the different pits to raise the coal. Pillage would have been completely prevented by an enclosed yard round the pit, and instead of the present requisite number of watchmen, one would have been sufficient. It would be endless to enter into any further detail of the savings that would have attended the adoption of the improved mode of working. I shall conclude by recommending strongly to the Grand Canal Company still to exert themselves to change the present wretched system, and if they attempt nothing else, at least a proper plan of ventilation might without risque be adopted, so as to prevent the necessity of sinking any new pits, many of which, on account of the depth, would be very expensive.*

* The Newtown colliery was for many years very unproductive, notwithstanding the enormous price of twenty shil-

The strata which rest upon the first bed of three foot coal are, first,—black slate clay, containing numerous balls of clay ironstone, usually arranged in beds of one inch in thickness. This bed varies in different places from three to twelve yards in thickness; it is succeeded by a bed of slaty sandstone, which on an average is five yards thick, above which is grey sandstone ten yards, then blue arenaceous slate-clay twelve yards. This bed is followed by the coal seat of the double seam.

SIXTH BED OF COAL, OR DOUBLE SEAM.

This bed, which is situated from forty to forty-five yards above the first bed of three foot coal, consists of two beds of coal separated by a bed of seat or fire-clay, which varies in thickness from six to eighteen inches; the upper bed of the coal is usually ten inches, and the lower twelve inches. Its occurrence in the district is very rare; it has never been met with except to the west of the great down throw, in

lings a ton being paid for coal at the pit mouth; but, within these last two years, Mr. Ross, the present manager, has by regularity and perseverance, changed the face of things, and rendered it very productive, though the country system of working is still persisted in to its full extent.

the Lordship of Castlecomer colliery, on the side of Coolbane hill, as represented in section No. 3, and immediately below the clay covering, at the engine pit of Newtown colliery. Its extent on Coolbane hill is very trifling. It only occurs between the two slips, represented in section No. 3. This bed has never been worked. It is covered by a bed of black slate-clay, which contains beautiful impressions of ferns, it is succeeded by the coal seat of the

SECOND OR UPPERMOST BED OF THREE FOOT
COAL.

It lies seven yards above the double seam. Its quality is very inferior to the first bed of three foot coal. It has not been met with in the district except between the two slips in Coolbane hill, already mentioned. Its extent is nearly equal to that of the double seam. This bed of coal, which is the uppermost in the district, is covered by a bed of black slate-clay interstratified with beds of clay ironstone, usually one inch in thickness; these alternations continue to the surface, and form the uppermost strata of the coal district.

Thus it appears that there are eight beds of coal in the principal division of the Leinster

coal district, which rest one upon the other in regular succession, namely,

1. The Rossmore foot coal.
2. The first bed of slate-coal.
3. The second bed of slate-coal.
4. The four foot coal.
5. The second foot coal, or Drummagh coal.
6. The first three foot coal.
7. The double seam.
8. The second three foot coal.

We shall now proceed to the consideration of the detached beds of coal.

DETACHED BEDS OF COAL.

In the foregoing pages the principal object has been to describe the general stratification, and the outgoings of the several beds of coal that occur in the great mineral bason which occupies the northern division of the Leinster coal district. The situation of some thin beds of coal, apparently unconnected with the others, still remain to be described.

In the lands of Rockbrook, to the south of Gaulstown, there is a thin bed of coal, on which some workings were formerly made.—The stratification is extremely regular in the valley of Rockbrook, and if the field of coal should prove extensive, it may be wrought to

advantage. Owing to the great thickness of alluvial matter which conceals the strata, no traces of the coal could be seen, except very indistinctly in two places. But from the appearance of the seat rock, and the general regularity of the stratification, this valley seems to merit a trial. The coal is apparently of a slaty nature, and may possibly be a continuation of the first or second bed of slate coal. Many trifling indications of coal have been observed south of Rockbrook, particularly near St. John's well, and at Ballygurteen, but the stratification undulates exceedingly, and the coal is rarely more than from four to six inches in thickness. To the west of Firoda, an irregular and undulating bed of slate-coal has been exposed to view in the channels of the mountain streams, particularly at Lowhill, and in that neighbourhood. A pit was formerly sunk on this bed to the north of Lowhill, and the usual tradition of a thick bed of good coal having been found, (though through bribery the pit was immediately closed up,) induced some persons to re-open it, some years ago, at a very considerable expence. When they arrived at the bottom, the bed was found to be composed of eight or ten inches of soft slate-coal. This pit was originally sunk in the centre of a steep and narrow undulation of the strata; for the same bed of coal, which is thirty yards deep where the pit was sunk, appears at the surface sixty yards to the west of it.

In the Cullenagh hills, which form the north western extremity of the district, four beds of slate-coal mixed with slate-clay have been discovered, but they are all thin, and even if they were of sufficient thickness, they could not be worked; for the strata on all sides dip into the hill at so steep an angle (frequently of 30° and even of 45° from the horizon) as to render it impossible to follow them for any distance, owing to the rapid increase in the thickness of the cover. Many trials have been made at different periods in all these beds; and some of the old pits were lately re-opened on the estates of Lord Norbury and Lord Tara, on Lord Norbury's property. At the depth of fourteen yards, a bed of coal mixed with slate and slaty coal one foot thick, was found, but there was only two inches of solid coal. An ancient borehole, carefully stopped at the top, was also discovered; it is said to be forty yards deep, and the old men assert that a *thick* bed of coal was found at the bottom: however from observations on the alternation of the rocks, below the first bed of coal in a neighbouring stream for more than forty yards, I can venture to contradict the report. The strata are so irregular and changeable, that a *thin* bed of coal might possibly have been found in the borehole, which either did not appear in the stream, or from its insignificance was passed over. But it may be safely

asserted that no bed of coal, even of one foot in thickness, exists there.

Two very impure and irregular beds of slaty coal were found on Lord Tara's estate, one of which varies from six to eighteen inches in thickness. Some trial pits have formerly been made on these beds, one of which has lately been cleared out, but nothing worth following was found. These discoveries and trials have all been made on the south side of the hills. In the stream to the north nothing was visible except the remains of some old workings for ironstone, which appear to have been very extensive. The ironstone was conveyed from Cullenagh to the iron works at Mountrath to be smelted.

Some years ago a trial was made at Blandsfort to the east of the Cullenagh hills, but without success; and from what I have seen of the stratification of the country, it is very unlikely that any workable bed of coal exists in the valley to the south of those hills.

OF FRUITLESS TRIALS FOR COAL.

During the last twelve years more than 200 pits and boreholes have been sunk in the royalty of Castlecomer, and by the Grand Canal Com-

pany in the royalty of Doonane. Very many of these have proved fruitless, and some have been made in situations where a little experience and some knowledge of the stratification of the country, would have been sufficient to have proved that no coal existed. Though many of the trials made by the proprietors of the Lordship colliery have likewise proved fruitless, they were all undertaken with a view to ascertain the extent of some particular bed of coal, in situations where the clay covering prevented any satisfactory observations being made on the stratification at the surface. The inconsiderate trials were made under the direction of a succession of English and Scotch coal viewers and agents, at the expence of the Grand Canal Company, who thus threw away many thousand pounds in sinking and boring for coal, beyond the outgoing of the first bed of slate coal, that is, through the strata which lie beneath it. Had Killeshin glen, or any of the other numerous deep cuts on the eastern face of the colliery hills between Corguee and Killeshin been carefully examined, it would have been discovered that no workable bed of coal exists in the first 860 feet above the limestone, and consequently the pit at Spring Hill never would have been sunk through black slate into the limestone, or the trial near Ballyckmoyler at the edge of the limestone would never have been commenced.

Many fruitless trials for coal have been made in the days of ignorance by country gentlemen and farmers, in the strata beyond the outgoing of the lowest workable bed of coal; but within these twelve years none have been attempted, excepting by the Grand Canal Company.

To enter into the detail of the erroneous and expensive system they have pursued, though it might prove a warning to future mining companies, would lead to a discussion of too great length. It is to be hoped, however, from what has been said, that no trial will in future be made beyond the edge of the lowest workable coal in the Leinster coal district.

The quantity of coal annually raised in the principal division of the Leinster coal district may be on an average about 70,000 tons of hard coal, and about 100,000 of soft coal or culm. The whole of the hard coal is raised from the Castlecomer and Newtown collieries, but in addition to them, culm is raised at the Firoda, Tollerton, Wolf Hill, and Clogrennan collieries, which increases the quantity of culm raised.

The price of coal at the pit mouth is twenty shillings a ton, and of culm about five shillings; but the price of culm varies according to the proximity of the collieries to the markets, from five to eight shillings a ton. The culm of the great collieries is composed of the hard coal broken small in the operation of working; but the culm of the thin beds is, as I have already

mentioned, naturally a soft slaty coal, which quickly divides into thin plates by exposure to the air, though it may have been brought up from the pit in large thick flakes. The principal markets for stone coal are Kilkenny, Carlow, and Athy. That brought to Kilkenny and Carlow is used in those towns, and their immediate neighbourhoods. The coal brought to Athy is chiefly sent by the Grand Canal to Dublin, Tullamore, and even by the river Shannon to Limerick. In distant places the coal is used only for malting, for which purpose it is peculiarly adapted, as it neither flames nor smokes. Stone coal is also shipped at Leighlin-bridge on the river Barrow, for the supply of the Ross and Waterford markets. The culm or soft coal of the Leinster coal district is chiefly used for burning lime, and for this purpose it is sent for by the farmers of all the surrounding counties, but particularly from the mountainous district of the counties of Wicklow and Wexford.

The coal of the first bed of three foot coal is by much the purest in the district. It has been used at the collieries to melt iron in cupola furnaces. Cast iron of the best quality might be made with this coal, if it could be raised at a sufficiently low rate; but at the present price of twenty shillings a ton it could not answer. On this account I have dwelt less than I should otherwise have done, on the number, quality,

and thickness of the different beds of clay iron-stone, which occur between each of the beds of coal, and also in other parts of the district where no coal exists.

Stone coal is peculiarly adapted to culinary purposes. When once perfectly ignited it will burn without any apparent alteration for many hours, but it is certainly less agreeable for general domestic purposes than bituminous or blazing coal. Owing to the high price of hard coal, and scarcity of turf, many of the peasants of the county of Kilkenny and Queen's county make an excellent substitute, by mixing pounded culm with one fourth part of clay; unctuous or friable mould answers much better than stiff clay, and probably bog-stuff will be found superior to either. The culm and clay are worked together like mortar, and then formed by the hand into balls of about three inches diameter. These balls are made use of instead of coal, and are put on the fire wet; when once ignited, they burn extremely well, and make a more agreeable and lively fire than the hard coal. The increased liveliness may be attributed to the balls being rendered porous from the shrinking of the clay by heat, the air (by this means) getting admission to the different sides of the small coal; whilst in the hard coal, the body is so compact, that nothing but the exterior surface is exposed. When a fire made of balls is well lit, it may be slacked down by a cake of the mixture of culm

and clay being laid wet on the top in a similar manner to bituminous coal.

OF MINERAL WATERS.

The chalybeate species is the only kind of mineral waters which occur in the Leinster coal district. The springs most frequented for their medicinal virtues are those of Castlecomer and Ballyspellan, neither of which are very strong. The waters which issue from the levels of the different collieries, and from some old boreholes, are much more strongly impregnated with sulphat of iron than they are. But the spa at Ballyspellan contains carbonic acid gas, in addition to the sulphat of iron.

OF ROADS AND CANALS.

The great leading roads from the collieries to the principal markets are generally kept in good repair, but the bye roads are execrable indeed. Many of them serve for the double purpose of a road and a river. The road from Castlecomer to Kilkenny is on the whole well laid out, but that from Castlecomer to Athy has been laid out over hill and dale, nearly in a straight line between the two places. A more level line of road might easily be formed, so as to avoid the hill of Doonane, Drimsallagh, and especially the summit of Corguee hill, but it is to be feared that the great expense

will for many years delay the completion of a new road in that direction. Within the last six years, a new road has been made between the collieries and Carlow. It was laid out with consummate skill and judgment by Mr. Aher, the manager of the Lordship of Castlecomer colliery. The chief part of the expence in making the road was raised by subscription in the country.*

A very practicable line of canal was laid out by Mr. Sparks, from the Grand Canal to the town of Castlecomer. This canal was at one period a favourite object with many gentlemen of the Queen's county, but at present it appears to be forgotten. This line, together with one laid out by Mr. Kilally, between the Grand Canal at Athy and the Nore above Kilkenny, are marked on my map of the coal district.

OF THE DIFFERENT METHODS OF WORKING COAL.

The collieries that have been wrought, and are at present at work in the Leinster coal district, have been, and are conducted in a

* The Dowager Countess of Ormonde subscribed £1000. towards this road. I am happy in having this opportunity of expressing my admiration of the liberal manner in which that lady at all times supports every project which may tend to the benefit of the country. To make her neighbours and tenants comfortable and happy, and to improve the surrounding country by every means in her power, appear the noble and patriotic boundary of Lady Ormonde's wishes and exertions.

faulty and expensive manner, in almost every department. With a view to point out the errors more clearly, and, if possible, to improve the present system, I shall give a short outline of the different approved methods of working coal, and describe the situations to which those different methods are applicable.

In the commencement of any coal work, the first object of attention should be to free the field of coal from water. This may be effected by a level, if the situation permits it; or by sinking a pit on the lowest point to the dip of the field of coal, so that all the water of the colliery may be conducted to the pit bottom, and thence raised to the surface by pumping engines, moved by steam, water, wind, or any power or means that is found most convenient. If the engine or water pit be in an improper situation, which is by no means an uncommon occurrence, the proprietor will necessarily be put to the expence of sinking a new pit, to unwater that part of the colliery which the first could not command, or sink the pit deeper, and drive a level in the under strata so as to meet the coal to the dip of the engine pit. Too much care cannot therefore be taken, previous to sinking an engine pit, to ascertain with accuracy the direction of the dip, and the angle of inclination which the coal or upper strata makes with the horizon. The upper strata are mentioned, as they are usually parallel to the coal;

and consequently if the direction of their dip and inclination can be taken at two or three places at the surface, and are found to agree, the engine pit may be sunk with confidence from the knowledge thus acquired.

This being effected, the next object of consideration is the mode of working which is suited to the particular bed of coal; this will be determined by the thickness of the bed, its depth from the surface, and the nature of the roof or rocky bed which covers it, and also of the floor, or rock which lies beneath.

There are two distinct methods of working coal, the *narrow* and the *long* or *broad* way; the narrow way is commenced by cutting passages through the coal, both length ways and across, leaving rectangular pillars between the passages. By the first operation one-third of the coal is generally taken out. But when found convenient, the pillars which remain are afterwards removed, commencing with the most distant, and ending with those next the pit. By the broad way, the coal is wrought out at once, frequently for a length of 150 yards in one face, without leaving any pillars of coal to support the roof. The former mode of working is adapted to beds of coal which occur a considerable depth beneath the surface, from 50 to 100 fathoms; and which have a strong roof either of sandstone or slaty-sandstone. The broad method is adapted to beds which lie nearer to the

surface, and which are covered by a tender roof of slate-clay, which falls quickly after the coal is removed.

OF THE NARROW METHOD OF WORKING COAL,

Most of the great and deep collieries in England are, with trifling variations, arising from various local circumstances, worked according to this plan. In taking a general view of the whole, I am inclined to give the preference to the improved system at present adopted at the collieries of Newcastle upon Tyne; and which, with trifling modifications, might be followed in any colliery.

This improved system has within the last eight years been brought to its present state of perfection, through the ability and unremitting exertions of Mr. Buddle, of Newcastle; and I have infinite satisfaction in having this opportunity of returning him thanks for the liberal manner in which he gave me information respecting his various improvements. According to Mr. Buddle's plan, from seven-eighths to nine-tenths of the coal is at present raised, whilst eight years ago but one half, and frequently less, was all that could be obtained, and therefore through his exertions, the coal owners of the north of England may be said to have en-

creased their property, at least one-third, as more coal than is equal to that proportion is now raised out of the same area, than could be effected according to the old system.

But Mr. Buddle's talents have not been confined solely to the improvement of working coal; he has also introduced a more perfect system of ventilation, and has put in practice many simple, but excellent contrivances, not only to prevent the accumulation of inflammable air in any part, but also by using hanging doors, which yield to the blast of inflammable air, and are not carried away; he prevents a general explosion throughout the mine when any cavity containing inflammable air is broken into accidentally as the works extend;—by this means, when the first blast is over, the general ventillation of the mine goes on as before, and the lives of the colliers and horses in the distant parts are preserved. None of our Irish collieries contain much inflammable air. I shall not at present therefore enter into any detail on this point, but shall confine my views to the different methods of working and supplying fresh air to the most distant parts of an extensive colliery, by one or more pits.

This knowledge will best be communicated by explaining the plate No. 6, which represents the plan of the improved system of working and ventillating collieries at Newcastle upon Tyne.

The circle below the letter A, is intended to represent a pit or shaft, divided from top to bottom by a boarded partition nicely jointed, so as to prevent the communication of air from one side of the pit to the other. Through the right hand division of this pit, which is called the *down-cast*, the air descends; having passed through all the excavations that have been made through the mine, which are represented by the white or uncoloured divisions, it passes up the left hand division of the pit. To aid the draught of air, a great fire is made in a furnace at B, which rarefies the air, and causes it to ascend more quickly through the *upcast* pit or division. The arrows point out the direction of the course of the air, throughout the mine, and the red marks are walls or stoppings, built to force the passage of the air in particular directions. The parts in the plate coloured black, represent the unwrought part of the coal.

The principal advantage of the new mode of working is, that it divides the mine into any convenient number of districts, each of which is to be wrought out in its turn, and the roof suffered to close in. But to prevent the crush created by the falling in of the roof in one part, from communicating with, and injuring the coal in another, a great protecting wall or pillar of coal is left between each division. By examining the plate No. 6, the several divisions or districts may be easily traced by observing the line of large pillars. The

first operation of working the coal is represented clearly in the district F. From the bottom of the pit, two parallel passages are cut three yards broad and twelve yards asunder; at convenient distances cross cut passages or headings are driven to connect the parallel passages, and thereby create a complete circulation or current of air.

The parallel passages are then continued until air again becomes deficient; a second heading is then cut, and the first is carefully closed up, so as to force the air round the lengthened circuit. This process is continued uninterruptedly around the district as represented on the plate. The district being thus surrounded, broad passages called *boards* or *rooms* are then commenced at the lower end of the district, and are cut at regular distances upward, towards the parallel passages first described. The breadth of the boards and that of the pillars of coal left between them, is continually varied according to the nature of the strata which forms the roof and floor of the coal. The usual breadth at Newcastle is 12 feet for the boards, and 6 feet for the headings, leaving a pillar of 60 feet by 33 between them. In the district F, the boards are represented in progress; this is also the case in the district K;—when the boards and headings have been made throughout a whole district, as is represented in the districts G and H, the next operation is to remove all the pillars; those at the

furthest extremity of the district are first cut out; this operation is performed either by commencing at one end, and proceeding regularly to the other, or by cutting the pillar in the middle, and setting a number of men to work at it. But this must depend on the strength of the roof. A few of the pillars of the district G are represented as being removed, and the whole of the coal that could be carried away is represented as being wrought out of district I, nothing except the trifling quantity shewn by the black lines, being left behind. When the pillars of the district G have been wrought out nearly to the boundary pillar between the districts I and G, the boundaries should be divided by boards and headways, and a considerable portion of them may thus be removed.

Owing to the frequent mistakes of sinking pits in improper situations, the pit A is placed in a position with respect to the colliery, that is frequently seen in practice, namely a great part of the coal field lying to the dip, or under the natural water level of the pit. By observing the direction of the dip and rise, as represented on the plan by the great arrow, it is evident that without some contrivance no coal could be level or water free below a line drawn across the pit A, at right angles to the arrow, and consequently half the coal of the districts F and G, and the whole of the district K, must have been left behind. To overcome this evil, the pit A

is supposed to be sunk below the coal to a depth more than equal to the level of the coal at M, and a drift or passage is supposed to be horizontally cut through the strata beneath the bed of coal till it meets the coal at M, by this means the district K may be freed from water. Had the pit been originally sunk nearer to M, all the expence and trouble of driving the stone drift would have been avoided.

It frequently happens that the stoppages, or walls built to direct the ventillation, interrupt the communication from the various parts where the coal is working to the pit bottom. When this happens, a door should be placed at a convenient distance on either side of the wall which may then be removed, and the leader of the coal waggons, as he passes along, opens the first door, and having led his waggons past, shuts it, and then opens the second door; by this means the regular ventillation of the mine is constantly preserved.

According to the plan just described, very extensive collieries are worked from one pit, at Newcastle on Tyne, and passages or boards, amounting in the aggregate to 30 miles in length, are perfectly ventillated by a single pit.

The mode of passing the air through the different passages or boards, varies according to circumstances; when a very quick current is required, the air is passed up one board and down the next; or as represented in the plan,

or up two boards and down two, or up three and down three. But in small collieries, or where no inflammable air is met with, the passage of air round the boundaries of a district, as that of F, leaving all the ends of the passages or boards open for the air to circulate, is found sufficient. At the great collieries at Newcastle, the ventillation consists of a current of air of 36 square feet, moving with a velocity of 3 feet in a second.

The different modes of removing the pillars according to circumstances, are represented in plate No. 7 a a, CC, D and e are the different modes of working pillars where it is necessary to preserve the air courses. The pillars are wrought in the manner represented at b b, where the outer parts are much damaged and cracked by the pressure of the roof and floor. And f f when the roof is not sufficiently strong to remain up while the whole pillar is removing. In this case the centre part is left, and both ends are carried away.

The consequence of working the boards too wide is represented in the elevation in the bottom of plate No. 7. The pillars on either side of the board g are represented as much broken, both at top and bottom, by the pressure of the roof and floor, and the coal is rendered useless. Besides the passage through the board is nearly closed by the approach of the roof and floor towards each other. The board H represents

the appearance in elevation of one that is driven of a proper width. In this case the coal on both sides is solid, and the roof and floor remain in their original positions. In working all collieries, it is better to drive the boards too narrow than too broad; in the first case when the pillars are to be removed, the roof and the coal are both sound, and the whole of it may with safety be removed; but in the latter the centre of the pillars, as represented by b b in the plate, can alone be taken away. When two pits are sunk in the same colliery, the air is carried down one pit, and having traversed the colliery, passes up the other.

BROAD METHOD OF WORKING COAL.

Many of the shallow and thin beds of coal in Yorkshire are worked in the broad way, but the breadth of the banks vary in almost every colliery, from certain local circumstances. I shall describe one, the principles of which may be applied to any shallow colliery, and the proper breadth of the banks, which depend on the nature of the roof, will be determined better by practice than precept.

Plate No. 8 represents a very simple and excellent method of working in the broad way. A is the shaft divided into two equal parts, in the

manner already described. B B B are double drifts, with proper headings for air. C C and D D are banks, each 50 yards broad. The dotted marks represent three rows of wooden pillars which support the roof. The light shade represents the parts already worked out where the roof has fallen.

The first operation in the work is to drive the several double drifts. Those on either side of the pit must be completed to the full extent before any other workings can go on. The three double drifts at right angles to the first may then be commenced, and having proceeded 20 or 30 yards, the great working or bank may be commenced, by breaking down the coal along the lines E E upwards. The coals are drawn out through any convenient headway to the pit bottom. Having broken down the coal across the whole bank for three yards to the rise, a row of wooden pillars should be placed from a yard to a yard and a half, to the rise of the coal pillar of the drift; and again, when four or five yards of coal have been wrought, two successive rows of wooden pillars should be placed to support the roof; when six yards of coal have been worked out of the bank, the hinder row of pillars may be removed, and placed in the front, and the roof suffered to fall down in the place the pillars stood. If the roof does not soon fall, it must be struck with picks and hammers, to bring it down, as there is danger in suffer-

ing too much weight to press upon the wooden pillars.

In the plate, the banks to the right and left are represented as having made considerable progress. The coals are drawn from the face of the banks on both sides through the openings or headways, by which the air is introduced, as represented by the arrows. I and F are double doors to prevent the air from the left bank returning directly to the pit; by this means it is forced along the face of the workings in the right bank. The first banks being proceeded on to a certain distance, a third and fourth may be commenced to the right and left, and others may be wrought to the rise by connecting the rise drifts by cross ones at right angles to them, and working upwards from the cross drifts, in the manner that has been described.

According to this plan a very extensive colliery may be worked from one pit, but horses must be used to draw the coal underground; and if the coal be thin, part of either the floor or roof must be removed to give sufficient headway. In speaking of Newtown colliery, the great benefit arising from having few pits at work, has already been mentioned, and the saving of labour both of men and horses, and the prevention of pillage, will be found to be immense. This article may therefore be concluded by the description of the most approved mode of con-

veying the coals from the face of the work to the pit bottom. First, a light cast iron railway must be laid from the pit bottom through all the main passages of the colliery, and branching from these, small moveable railways should be laid from the nearest point of the main passage or mother-gate, as it is usually called, to the face of the workings. When the collier has broken down the coals, another man, known by various names, as putter, hurrier, &c. is employed to fill the coal into a wicker basket, or wooden box, placed on a wooden carriage with iron wheels; this is pushed to the mother-gate along the rail way, and the putter returns with an empty box which has been left in the mother gate, and so on. When a certain number, suppose six, of these full boxes have been left at the mother gate, a waggon boy arrives from the pit, leading a horse, which draws six carriages chained together, each having an empty box on it. These boxes are lifted off, and by means of a small *crane* the full boxes are successively raised and placed on the carriages, which when thus laden are drawn by the horse along the rail way to the pit bottom, from whence the boxes are drawn up to the surface, and empty ones returned.

The minuteness with which I have described the different methods of working coal, must, I am sensible, appear tedious and unnecessary to general readers, but my object has been to ex-

plain the latest improvements so distinctly as to enable the proprietors of Irish collieries, to adopt such of them as may be judged advisable, and thus to correct the faults of the erroneous system of working now pursued throughout Ireland, and enable them to conduct their mines hereafter upon the most oeconomic and scientific principles. How far I have succeeded in attaining this important end of *practical utility* must be determined by others; but I feel that I must trust to the indulgence which I have uniformly received from a candid and liberal public, for the pardon of those errors which have probably occurred in this report; and I shall be happy if my further researches on this subject should enable me to correct those inaccuracies which, in the course of so long a work, and in the prosecution of extensive inquiries into local, though important facts, it was perhaps impossible altogether to avoid.

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APPENDIX.

Detail of the strata met with in the different pits and borings in the Leinster coal district, referring to the numbers marked on the map.

NO. 1, TRIAL AT BALLYNAGALL.

	Yds.	Ft.	In.
Black slate clay	19	2	8
Flinty slate, not penetrated			

NO. 2.—TRIAL PIT AT SPRINGHILL.

Black slate clay	54	0	0
Limestone, not penetrated			

NO. 3.—BOREHOLE AT OLD LEIGHLIN.

Black slate clay	40	0	0
	1	2	

NO. 4.—BORING AT NEWTOWN HARPOLE.

			Yds.	Ft.	In.
Clay and gravel	-	-	11	2	2
Blue slate clay	-	-	3	2	6
Soft brown slaty sandstone	-	-	1	1	4
Hard grey sandstone	-	-	1	0	0
Brown slaty sandstone	-	-	0	2	7
Black slate clay	-	-	0	1	5
COAL and CULM, mixed with slate clay	-	-	0	1	7
Fire clay or coal seat	-	-	3	0	1
Hard grey sandstone	-	-	6	2	5
Grey slaty sandstone	-	-	0	1	10
Grey sandstone	-	-	1	0	1
Grey slaty sandstone	-	-	3	1	3
Grey sandstone	-	-	0	2	1
Blue slate clay	-	-	0	1	5
COAL	-	-	0	1	0
Fire clay or coal seat	-	-	0	2	0
Sandy seat rock	-	-	1	2	7
Blue slate clay	-	-	0	0	8
COAL	-	-	0	0	1
Slaty sandstone	-	-	0	1	6
Grey sandstone, extremely hard	-	-	4	0	6
Grey slaty sandstone	-	-	1	2	6
Grey rock, extremely hard, not penetrated	-	-	2	1	10
			48	0	5

NO. 5.—FARNANS.

			Yds.	Ft.	In.
Soil and clay	-	-	2	0	0
Blue slate clay	-	-	23	0	5
Grey arenaceous slate clay	-	-	22	0	0
Blue slate clay	-	-	1	0	6
Grey slaty sandstone	-	-	2	1	0
Blue slate clay	-	-	1	0	8
Grey slaty sandstone	-	-	30	0	5
			82	0	0

NO. 6.—FARNANS.

Soil and clay	-	-	1	2	0
Grey slaty sandstone	-	-	0	1	0
Clay ironstone	-	-	0	0	1
Black slate clay	-	-	15	2	10
Grey slaty sandstone	-	-	7	0	0
Blue slate clay	-	-	1	0	0
Grey slaty sandstone	-	-	25	0	0
			50	2	11

NO. 7.—CLOGRENNAN COLLIERY.

			Yds.	Ft.	In.
Soil and clay	-	-	2	0	0
Blue slate clay	-	-	2	0	0
Grey slaty sandstone	-	-	6	0	0
Black slate clay, coal roof	-	-	3	0	0
COAL	-	-	0	0	1
Grey sandstone	-	-	1	0	0
Grey slaty sandstone	-	-	5	0	0
Black slate clay	-	-	2	0	6
COAL	-	-	0	1	0
			21	1	7

NO. 8.—CLOGRENNAN COLLIERY.

Grey slaty sandstone	-		5	0	0
Hard grey sandstone	-		3	0	0
Striped slaty sandstone	-		5	0	0
Black slate clay, coal roof	-		5	0	0
		Feet In.			
Slaty COAL called kennel	0	2	}	0	1 6
COAL	1	0			
Soft slaty COAL or helve	0	4			
Fire clay or coal seat	-		0	2	0
Sandstone seat rock, with impressions of rushes	-	-	0	2	0
Carried forward	-		19	2	6

		Yd.	F.	lb.
Brought forward	-	19	2	6
Hard gray sandstone	-	1	0	0
Black slate clay, coal roof	-	0	1	2
COAL	-	0	0	1
Coal seat, or fire clay	-	0	0	3
Slaty seat rock	-	0	2	0
Striped slaty sandstone	-	2	0	0
Grey sandstone	-	0	1	0
Striped slaty sandstone	-	4	0	0
Grey sandstone, inclining to flag	-	6	2	0
Hard grey sandstone	-	3	1	0
Grey slaty sandstone	-	1	1	0
Blue slate clay	-	0	1	0
Light grey sandstone very hard	-	4	0	0
Grey slate clay	-	0	2	0
Grey slaty sandstone	-	0	1	6
Slate clay	-	0	2	0
Grey sandstone	-	1	1	0
Grey slaty sandstone	-	2	0	0
Grey sandstone	-	1	0	0
Dark blue slate clay	-	6	2	0
Clay ironstone	-	0	0	2
Dark blue slate clay	-	4	0	0
Clay ironstone	-	0	0	2
Dark blue slate clay	-	1	0	0
Slaty sandstone	-	0	2	0
Sandstone mixed with slate clay	-	0	2	0
Carried forward	-	63	0	10

		Yds.	Ft.	In.
Brought forward	-	63	9	10
Slate clay	-	0	0	6
Slaty sandstone	-	0	0	6
Hard grey sandstone	-	0	1	6
Slaty sandstone	-	0	2	0
Dark grey sandstone	-	0	1	0
Slate clay	-	0	2	0
Clay ironstone	-	0	0	4
Black slate clay	-	1	1	0
COAL	-	0	0	4
Seat clay	-	0	0	6
Seat rock	-	0	1	0
Dark grey sandstone	-	1	1	0
Slaty sandstone approaching to slate, containing beds of clay ironstone		3	1	0
Dark grey sandstone	-	0	2	0
Slate clay passing into slaty sandstone		2	0	0
Slaty sandstone	-	6	0	0
Black slate clay, coal roof	-	3	0	0
COAL	-	0	1	0
Seat clay and seat rock	-	1	0	0
Slaty sandstone	-	5	0	0
Slate clay	-	0	2	6
		91	1	0

BOREHOLE AT CLOGRENNAN COLLIERY NEAR THE
NEW PIT.

		Yds.	Ft.	In.
Grey sandstone	-	0	2	6
Slaty sandstone	-	0	2	0
Grey sandstone	-	0	1	0
Slaty sandstone	-	0	1	0
Soft slaty sandstone	-	1	0	0
Grey sandstone	-	0	0	6
Slate clay parting	-	0	0	2
Hard slaty sandstone in beds from 6 to 10 inches, with soft partings between	-	6	1	0
Slaty sandstone very hard, containing sulphur	-	0	0	5½
Slaty parting	-	0	0	2½
Slaty sandstone, very hard, with sul- phur	-	0	0	11
Slate clay rather soft	-	1	0	0
Clay ironstone	-	0	0	1
Slate clay rather soft	-	1	0	8
Hard slaty sandstone	-	0	0	9
Slate clay parting	-	0	0	3⅛
Hard slaty sandstone	-	0	0	10
Slate clay	-	0	0	4½
Hard slaty sandstone	-	0	1	0
Carried forward	-	13	1	9

			Yds.	Ft.	In.
Brought forward			13	1	9
Slaty sandstone with many slate partings	-	-	0	1	0
Soft reddish slate clay parting			0	0	2 $\frac{1}{2}$
Black roof slate	-		0	0	4
Clay ironstone	-		0	0	1
Black roof slate	-		0	1	2
		Ft. In.			
Solid COAL	-	1 1	}	0	1 5 $\frac{1}{2}$
Slaty COAL parting		0 0 $\frac{1}{2}$			
Solid COAL, slaty structure		0 4			
Hard seat clay	-	-	0	2	0
Slaty COAL	-	-	0	0	10
Fire clay	-	-	0	2	0
			16	1	10

NO. 9. PIT AT THE RUSHES.

Grey sandstone, hard and coarse grained	-	-	5	0	0
Dark blue slate clay	-		6	2	0
Greyish blue micaceous slate clay			0	2	0
Clay ironstone	-		0	0	3
Grey sandstone	-		3	1	6
Carried forward	-		15	2	9

		Yds.	Ft.	In.
Brought forward	-	15	2	9
	Ft. In.			
Solid COAL	- 1 6	}	1	0
CULM	- 0 3			
COAL mixed with slate clay	1 3			
Dark grey fire clay	-		1	0
			17	2
			9	

NO. 10. CORGEE COLLIERY.

Grey sandstone	-	3	1	0
Black indurated slate clay resembling Lydian stone	-	3	0	0
Blue slate clay	-	6	0	0
Blue slaty sandstone	-	1	1	6
	Ft. In.			
COAL	- 1 6	}	0	2
CULM or kelve	- 0 3			
COAL mixed with slate clay	1 0			
Fire clay	-		1	1
Sandstone seat rock	-		3	0
			19	0
			9	

Carried forward

NO. 11. MOIRA COLLIERY.

			Yds.	Ft.	In.
Soil and clay	-	-	3	1	0
Brown sandstone	-	-	6	0	6
Black slate clay, mixed with beds of clay ironstone	-	-	8	0	0
		Ft. In.			
COAL	-	1 1	1	0	3
CULM mixed with slaty coal	2	2			
Fire clay	-	-	1	0	3
			19	2	0

NO. 12. TOLLERTON COLLIERY.

Grey slaty sandstone	-	12	0	0
Coarse grained grey sandstone frequently containing fragments of slaty sandstone, and black slate and coal partings. Beds vary in thickness from 15 inches to 4 feet. The beds are usually separated by beds of slate or slaty sandstone from 1 inch to 2 feet in thickness				
		12	0	0
Carried forward	-	24	0	0

		Yds.	Ft.	In.
Brought forward	-	24	0	0
COAL, from $\frac{1}{4}$ of an inch to 2 inches		0	0	2
Grey sandstone, usually the coal roof, but sometimes there is a bed of slate below it which varies in thickness from 1 to 4 feet		6	0	0
	Ft. In.			
Kennel	0 4	}	1	0
Solid COAL, from 18 inches				
to	2 0			
KELVE	0 4			
Clearing	0 10			
		31	0	2

NO. 13. FIRODA COLLIERY.

Soil and clay	-	3	0	0
Hard grey sandstone	-	8	0	0
Blue slate clay	-	8	0	0
Grey micaceous slaty sandstone		8	0	0
COAL	-	0	1	6
		27	1	6

NO. 14.—GARRENDINA HILL.

			Yds.	Ft.	In.
Grey slaty sandstone			6	0	0
Black slate clay, with clay ironstone			6	0	0
COAL		Ft. In.			
		1 1			
CULM mixed with slate		0 5	0	1	0
			12	1	6

NO. 15.—GARRENDINA HILL.

Soil and clay	-	-	2	0	0
Slaty sandstone	-	-	3	0	0
Slate clay with clay ironstone			5	1	7
COAL		Ft. In.			
		1 1			
CULM mixed with slate		0 5	0	1	6
			11	0	1

NO. 16.—LOON ORCHARD.

Soil and clay	-	-	12	1	6
Grey slaty sandstone	-	-	3	1	6
Carried forward	-	-	16	0	0

	Yds.	Ft.	In.
Brought forward	16	0	0
Grey sandstone	0	1	8
Blue arenaceous sandstone	2	1	1½
Clay ironstone	0	0	1½
Blue arenaceous slate	5	0	6
Blue slate clay	1	1	8
Clay ironstone	0	0	1
Blue slate	0	2	0
Clay ironstone	0	0	2
Blue slate	1	1	1
Clay ironstone	0	0	2
Black slate	1	0	7
COAL	0	0	8
Coal seat	0	0	11½
Seat rock	0	0	3
	29	2	0½

NO. 17, PIT IN MONTEEN COLLIERY.

Clay	2	0	0
Grey sandstone	8	0	0
Black slaty sandstone	2	2	3
Dark grey sandstone containing calca- reous impressions of muscle shells,	1	0	0
Black slaty sandstone	0	1	6
Carried forward	14	0	9

	Yds.	Ft.	In.
Brought forward	14	0	9
Grey sandstone	1	0	0
Grey slaty sandstone	0	1	6
Light grey sandstone	3	2	9
Black curled sandstone	0	1	0
Black slaty sandstone	1	1	0
Black curled sandstone	1	2	9
Black sandstone	1	0	0
Grey slaty sandstone	1	0	6
Grey curled sandstone	1	0	9
Black sandstone, sunk to this	0	2	0
Grey sandstone, bored from this	1	0	5
Blue arenaceous slate	0	2	0
Grey sandstone	0	1	2
Blue arenaceous slate	1	1	9
Sandstone	0	0	2 $\frac{1}{2}$
Blue arenaceous slate	1	1	11 $\frac{1}{2}$
Ironstone	0	0	1 $\frac{1}{2}$
Blue arenaceous slate	1	0	3 $\frac{1}{2}$
Ironstone	0	0	2
Blue arenaceous slate	0	1	1 $\frac{1}{2}$
Black slate clay	1	0	1 $\frac{1}{2}$
Black slaty sandstone	2	0	11
Ironstone	0	0	1
Black slaty sandstone	0	1	4
Ironstone	0	0	1
Grey slaty sandstone	1	1	9
Blue slaty sandstone	0	1	6
Carried forward	40	1	0

		Yds.	Ft.	In.
Brought forward	-	40	1	0
Ironstone	-	0	0	$1\frac{1}{2}$
Blue arenaceous slate	-	1	0	$2\frac{1}{2}$
Ironstone	-	0	0	1
Blue arenaceous slate	-	0	1	7
Ironstone	-	0	0	$1\frac{1}{2}$
Blue arenaceous slate	-	2	0	$3\frac{1}{2}$
Ironstone	-	0	0	$1\frac{1}{2}$
Blue arenaceous slate	-	0	1	5
Ironstone	-	0	0	$1\frac{1}{2}$
Black slate	-	1	1	8
Ironstone	-	0	0	1
Black slate	-	1	0	$11\frac{1}{4}$

	Yd.	Ft.	In.			
KELVE	0	2	4	}	2	0 4
COAL	1	1	0			
Black slate	-	-	-		0	2 0
					50	1 $1\frac{1}{2}$

NO. 18.—GENEVA COLLIERY.

Soil and clay	-	-	3	1	6
Grey sandstone	-	-	1	0	6
Black slaty sandstone	-	-	14	1	0
Grey sandstone	-	-	1	1	6
Carried forward			20	1	6

				Yds.	Ft.	In.
Brought forward	-			20	1	6
Black slate clay with ironstone				6	0	0
			Yds. Ft. In.			
KELVE	-	-	0 0 8	}	1	2
COAL	-	-	1 0 4			
Slaty COAL or CULM			0 1 0			
Black slate clay					1	0
					0	0
					<u>29</u>	<u>0 6</u>

 NO. 19.—AHAMUCKY.

Passing into slaty sandstone.	Clay	-	1	0	0
	Grey sandstone	-	4	2	6
	Micaceous, slate parting		0	0	2
	Grey sandstone	-	1	1	2
	Micaceous, slate parting		0	0	2
	Grey sandstone	-	1	0	1
	Micaceous, slate parting		0	0	2
	Grey sandstone	-	1	0	1
	Micaceous, slate parting		0	0	1
	Grey sandstone	-	1	0	11
	Micaceous, slate parting		0	0	1½
	Grey sandstone	-	1	1	5½
	Micaceous, slate parting		0	0	1½
	Grey sandstone	-	1	0	8½
	Micaceous, slate parting		0	0	2
	Grey sandstone	-	0	2	8½
	Carried forward	-	14	1	7½

		Yds.	Ft.	In.
Brought forward	-	14	1	7 $\frac{1}{2}$
Grey slaty sandstone	-	2	1	0
Grey sandstone, passing from slaty	-	1	1	0
Grey soft slaty sandstone	-	1	1	11
Grey slaty sandstone	-	0	1	9
Grey sandstone	-	0	0	5
Grey slaty sandstone	-	1	0	2
Micaceous, slate parting	-	0	0	2
Slaty sandstone	-	1	1	3
Micaceous, slate parting	-	0	0	1
Slaty sandstone	-	0	2	3
Micaceous, slate parting	-	0	0	2
Slaty sandstone	-	1	0	9
Micaceous slate parting	-	0	0	2
Sandstone	-	0	2	10 $\frac{1}{2}$
Micaceous slate parting	-	0	0	1 $\frac{1}{2}$
Sandstone, grey and slaty	-	1	2	3
Blue arenaceous slate clay	-	0	1	7
Blue slate clay	-	0	0	11
Clay ironstone	-	0	0	1 $\frac{1}{2}$
Black slate	-	0	2	1
COAL	-	0	2	8
Black slate	-	0	2	6
Blue slate	-	0	0	8
Slaty sandstone, hard	-	0	1	6
Blue slate	-	0	2	4
Slaty sandstone	-	0	1	10
Blue arenaceous slate	-	1	2	1
Hard grey sandstone	-	0	1	0
Total		35	1	3

NO. 20.—MASSFORD.

Deep borehole to Four Foot Coal.

	Yd.	Ft.	In.
Sunk to seat rock, bored the re-			
mainder	8	0	7
Grey slaty sandstone	2	1	6
Grey sandstone	0	2	7
Blue slaty sandstone	0	2	10
Blue slate clay	0	1	1
Slate clay <i>ironstone</i>	0	0	1½
Blue slate clay	0	1	8½
Slate clay <i>ironstone</i>	0	0	1½
Black slate clay	0	1	4½
Hard sandstone	0	1	2
Black arenaceous slate	0	2	10
Slate clay <i>ironstone</i>	0	0	2
Black slate clay	0	2	6
COAL	0	0	5½
Hard sandstone	1	0	8
Slaty sandstone	0	0	3½
Black stone	0	2	4
Grey slaty sandstone	0	0	8
Clay ironstone	0	0	2
Blue slaty sandstone	0	1	3
Grey sandstone	0	2	4
Blue slate clay	0	2	8
Hard grey sandstone	3	0	0
Carried forward	23	2	5

	Yds.	Ft.	In.
Brought forward	23	2	5
Grey slaty sandstone	0	0	6
Hard grey sandstone	1	1	1
Grey slaty sandstone	0	2	1
Clay ironstone	0	0	3
Blue slaty sandstone	1	1	7
Clay ironstone	0	0	2
Blue slate clay	0	2	0
Grey slaty sandstone	0	1	1
Hard grey sandstone	0	0	11
Grey slaty sandstone	1	2	7
Blue slaty sandstone	3	0	2
Grey sandstone	0	2	4
Slate clay	0	0	1
Hard grey sandstone	0	1	5 $\frac{1}{2}$
Slate clay	0	0	0 $\frac{1}{2}$
Grey slaty sandstone	0	0	4
Clay ironstone	0	0	2 $\frac{1}{2}$
Grey slaty sandstone	0	1	5
Clay ironstone	0	0	2 $\frac{1}{2}$
Grey slaty sandstone	1	0	10
Blue arenaceous slate clay	0	2	6
Grey sandstone	0	1	7
Blue arenaceous slate clay	0	0	11
Clay ironstone	0	0	1 $\frac{1}{2}$
Grey slaty sandstone	0	1	3 $\frac{1}{2}$
Clay ironstone	0	0	1 $\frac{1}{2}$
Blue arenaceous slate clay	1	1	2
Clay ironstone	0	0	2 $\frac{1}{2}$
Carried forward	40	2	8

	Yds.	Ft.	In.
Brought forward	40	2	8
Blue arenaceous slate clay	3	0	3
Clay <i>ironstone</i>	0	0	1
Blue slate clay	0	1	8
Black arenaceous slate clay	1	0	1
Black sandstone	0	2	11
Micaceous slate clay	0	0	1
Grey sandstone	1	0	7
Grey slaty sandstone	2	1	6
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Grey slaty sandstone	1	1	9 $\frac{1}{2}$
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	3	0	8
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	1	0	2
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	1	0	6
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Blue arenaceous slate clay	0	1	6 $\frac{1}{2}$
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Blue arenaceous slate clay	2	0	1 $\frac{1}{2}$
Clay <i>ironstone</i>	0	0	2
Strong blue slate clay	0	2	1
Slate clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Black slate clay	1	0	8 $\frac{1}{2}$
Slate clay <i>ironstone</i>	0	0	1
Black slate clay	0	2	9
Slate clay <i>ironstone</i>	0	0	1
Black slate clay	1	0	9
Carried forward	64	1	3

					Yds.	Ft.	In.
Brought forward	-				64	1	3
					Yds.	Ft.	In.
Strong KELVE	-				0	1	11
KELVE mixed with slate							
clay	-	-			0	1	0
KELVE	-	-			0	2	6
COAL	-	-					
Slate clay	-	-					
					1	0	0
					0	0	5 $\frac{1}{2}$
					Yds.	Ft.	In.
COAL	-	-			0	1	2 $\frac{1}{2}$
KELVE and COAL	-	-			0	0	1 $\frac{1}{2}$
COAL	-	-			0	0	3 $\frac{1}{2}$
Very hard slate clay							
Clay <i>ironstone</i>	-	-					
Slate black and gully	-	-					
					0	0	3
					0	0	1
					0	0	2
					68	0	3

NO. 21.—MONEEN ROE, NEAR MASSFORD.

Pit sunk, bored the remainder					15	2	0
Grey slaty sandstone	-				2	1	0
Black slaty sandstone, hard	-				0	0	7
Grey slaty sandstone	-				1	2	5
Clay <i>ironstone</i>	-	-			0	0	2
Black slate clay	-	-			0	1	10
Grey slaty sandstone	-	-			0	1	6
Clay <i>ironstone</i>	-	-			0	0	2
Carried forward	-				21	0	8

			Yds.	Ft.	In.
Brought forward	-	-	21	0	8
Strong slate clay	-	-	1	2	0
Clay <i>ironstone</i>	-	-	0	0	2
Slate clay	-	-	1	0	2
Grey slaty sandstone	-	-	0	1	8
Hard grey sandstone	-	-	1	0	6
Blue arenaceous slate clay	-	-	0	1	8
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Slate clay	-	-	1	0	7
Clay <i>ironstone</i>	-	-	0	0	2 $\frac{1}{2}$
Slate clay	-	-	0	1	4
Gray slaty sandstone	-	-	0	1	2 $\frac{1}{2}$
Grey sandstone	-	-	0	1	5
Black slaty sandstone	-	-	0	0	3
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Slate clay	-	-	1	0	0
COAL	-	-	0	0	2
Slate clay	-	-	0	0	3
Grey sandstone	-	-	0	0	4
Grey slaty sandstone	-	-	0	0	9
Hard grey sandstone	-	-	0	2	2
Micaceous slate clay	-	-	0	0	2
Hard grey sandstone	-	-	0	1	6
Grey slaty sandstone	-	-	1	0	1
Hard grey sandstone	-	-	1	0	11 $\frac{1}{2}$
Slate clay	-	-	0	0	0 $\frac{1}{2}$
Hard grey sandstone	-	-	0	0	8
Grey slaty sandstone	-	-	0	1	3
Hard grey sandstone	-	-	0	1	7
Carried forward	-	-	35	1	0

	Yds.	Ft.	In.
Brought forward	35	1	0
Grey slaty sandstone	0	0	6
Hard grey sandstone	0	1	1
Micaceous slate clay	0	0	0 $\frac{1}{2}$
Hard grey sandstone	0	1	0
Grey slaty sandstone	0	0	7
Grey sandstone	0	2	11 $\frac{1}{2}$
Grey slaty sandstone	0	0	4
Grey sandstone	1	2	0
Micaceous slate clay	0	0	1
Grey sandstone	0	1	7
Grey slaty sandstone	1	1	11
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	2	0	9
Clay <i>ironstone</i>	0	0	1
Blue arenaceous slate clay	0	1	8
Slate clay	0	1	7
Hard black slaty sandstone	0	2	1
Hard grey sandstone	0	2	0
Grey slaty sandstone	1	0	9
Clay <i>ironstone</i>	0	0	1
Grey slaty sandstone	0	2	1
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	1	0	8
Clay <i>ironstone</i>	0	0	1
Blue arenaceous slate clay	1	1	9
Clay <i>ironstone</i>	0	0	4
Blue arenaceous slate clay	1	0	4
Grey sandstone	0	1	4
Carried forward	52	2	0

	Yds.	Ft.	In.
Brought forward	52	2	0
Grey slaty sandstone	0	2	9
Grey sandstone	0	2	5
Grey slaty sandstone	0	1	6
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Grey slaty sandstone	1	1	8 $\frac{1}{2}$
Coarse grained blue slate clay	0	1	5
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	0	2	11
Clay <i>ironstone</i>	0	0	2
Blue slate clay	0	2	9
Blue arenaceous slate clay	0	0	4
Grey slaty sandstone	1	1	6
Grey sandstone	1	1	9 $\frac{1}{2}$
Micaceous slate clay parting	0	0	1 $\frac{1}{2}$
Blue arenaceous slate clay	1	0	0
Clay <i>ironstone</i>	0	0	2
Blue arenaceous slate clay	0	2	1
Hard grey sandstone	0	2	8
Grey slaty sandstone	1	2	6 $\frac{1}{2}$
Blue arenaceous slate clay	0	0	11 $\frac{1}{2}$
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Blue arenaceous slate clay	0	0	2 $\frac{1}{2}$
Very hard clay <i>ironstone</i>	0	0	3
Blue arenaceous slate clay	2	0	8
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Blue slaty sandstone flag	0	0	3
Slate clay	0	1	7
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Slate clay	0	1	3
Carried forward	70	1	8

			Yds.	Ft.	In.
Brought forward			70	1	8
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	0	9
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	1	7
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	2	7
Clay <i>ironstone</i>	-	-	0	0	2
Blue slate clay	-	-	0	1	0
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	0	5
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	6
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	8
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	11
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	7
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	0	5
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	5
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	10
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	1	3
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	0	6
Carried forward			75	0	7

			Yds.	Ft.	In.
Brought forward	-	-	75	0	7
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	6
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	1	4 $\frac{1}{2}$
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	2	6
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	5
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	0	0	4
Clay <i>ironstone</i>	-	-	0	0	1
Blue slate clay	-	-	0	0	6 $\frac{1}{2}$
Clay <i>ironstone</i>	-	-	0	0	1
Black slate clay	-	-	3	0	5
		Ft. In.			
KELVE and pyrites	-	2 10	2	0	10
COAL	-	4 0			
Slate clay	-	-	0	2	2
Grey sandstone, not penetrated	-	-	0	0	5
Total depth bored			83	1	9

NO. 22.—BORING BELOW 3 FOOT SEAM ON THE
TOP OF COOLBANE HILL.

Blue arenaceous slate clay	-	-	1	1	10
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Carried forward	-	-	1	1	11 $\frac{1}{2}$

		Yds	Ft.	In.
Brought forward	-	1	1	11 $\frac{1}{2}$
Blue arenaceous slate clay	-	2	1	7
Clay <i>ironstone</i>	-	0	0	2
Blue arenaceous slate clay	-	2	1	8
Clay <i>ironstone</i>	-	0	0	2 $\frac{1}{2}$
Blue slate clay	-	0	2	8
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	0	2	3 $\frac{1}{2}$
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	1	0	0 $\frac{1}{2}$
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	1	2	1
Clay <i>ironstone</i>	-	0	0	1
Black slate clay	-	1	1	10
FIRST BED OF THREE FOOT COAL		1	0	0
Coal seat, bored from this	-	0	2	0
Coal seat	-	1	1	2
Grey slaty sandstone	-	0	2	6
Slate clay	-	1	2	0
Clay <i>ironstone</i>	-	0	0	2
Slate clay	-	1	1	9
Grey sandstone	-	0	1	5
Grey slaty sandstone	-	0	1	0
Grey sandstone	-	0	2	4
Grey slaty sandstone	-	1	2	3
Grey sandstone	-	0	2	3
Micaceous slate clay	-	0	0	3
Grey slaty sandstone	-	0	2	6
Grey sandstone	-	0	0	8
Carried forward	-	25	1	4

					Yds.	Ft.	In.
Brought forward	-				25	1	4
Grey slaty sandstone	-				0	0	8
Clay <i>ironstone</i>	-				0	0	2
Slate clay	-				1	2	8
Grey sandstone	-				0	2	11
Black arenaceous slate clay	-				0	1	0
Soft black smut	-	0	0	1	}	0	0
COAL	-	0	0	2			
Coal seat	-				1	0	7 $\frac{1}{2}$
Seat rock or grey sandstone	-				0	1	4
Grey slaty sandstone	-				0	1	0
Grey sandstone	-				0	1	3
Grey slaty sandstone	-				0	0	8
Grey sandstone	-				2	0	6
Micaceous slaty clay	-				0	0	2
Grey slate sandstone	-				0	2	10
Grey sandstone	-				0	2	8
Micaceous slate clay	-				0	1	0
Grey slaty sandstone	-				0	2	10
Clay <i>ironstone</i>	-				0	0	2 $\frac{1}{2}$
Slate clay	-				0	2	8
Clay <i>ironstone</i>	-				0	0	2
Slate clay	-				0	1	8
Grey sandstone	-				3	2	11 $\frac{1}{2}$
Micaceous slate clay	-				0	0	1
Grey sandstone	-				0	2	8 $\frac{1}{2}$
Micaceous slate clay	-				0	0	3
Grey sandstone	-				3	1	1
Grey slaty sandstone	-				2	0	1
Light grey sandstone	-				0	0	8 $\frac{1}{2}$
Carried forward	-				49	0	5 $\frac{1}{2}$

					Yds.	Ft.	In.
Brought forward	-				49	0	5 $\frac{1}{2}$
Grey slaty sandstone	-				2	2	7
Grey sandstone	-				0	0	5
Grey slaty sandstone	-				0	0	6
Slate clay	-				1	0	4 $\frac{1}{2}$
Grey sandstone	-				0	0	9 $\frac{1}{2}$
Grey slaty sandstone	-				0	1	5
Grey sandstone	-				0	1	1 $\frac{1}{2}$
Grey slaty sandstone	-				0	2	1
Clay <i>ironstone</i>	-				0	0	3
Slate clay	-				1	2	3
Clay <i>ironstone</i>	-				0	0	3
Grey slaty sandstone	-				0	1	10
Clay ironstone	-				0	0	3
Slate clay black	-				0	2	11
Soft black smut	-	0	0	3	0	0	6 $\frac{1}{2}$
COAL	-	0	0	3 $\frac{1}{2}$			
Coal seat or fire clay	-				2	1	8
Seat rock or grey sandstone	-				1	0	6
Grey slaty sandstone	-				0	1	0
Grey sandstone,	-				1	0	3
Grey slaty sandstone	-				0	1	6
Light grey sandstone	-				1	1	0
Micaceous slate clay	-				0	0	5
Light grey sandstone	-				0	1	5 $\frac{1}{2}$
Sandstone not penetrated	-				15	1	2
Total depth					82	0	0

NO. 23.—TOURTANE.

	Yds.	Ft.	In.
Clay	8	0	0
Slaty sandstone, <i>sunk to this and bored</i> <i>from it</i>	5	2	3
Grey sandstone with partings	4	0	1
Ironstone, probably slaty	0	0	6
Slaty sandstone	3	0	0
Clay ironstone	0	0	3 $\frac{1}{2}$
Hard slaty sandstone	2	1	10
Grey slaty sandstone	1	1	10
Dark grey sandstone	1	0	4
Slaty sandstone	2	2	8
Hard grey sandstone	1	0	8
Grey slaty sandstone	0	2	4
Clay ironstone	0	0	2
Blue slate clay	1	0	6
Clay ironstone	0	0	3
Blue slate	0	2	6 $\frac{1}{2}$
Blue arenaceous slate	9	1	1 $\frac{1}{2}$
Clay <i>ironstone</i>	0	0	1
Blue slate clay	0	2	9
Clay <i>ironstone</i>	0	0	1
Black slate	0	0	6
COAL	0	1	0
Coal seat not penetrated	0	0	6
	44	1	3 $\frac{1}{2}$

NO. XXIV.—CRUTENCLOUGH.

		Yds.	Ft.	In.
Clay	-	4	2	3
Blue arenaceous slate	-	4	0	0
Black curled sandstone	-	4	0	0
Grey slaty sandstone	-	2	0	0
Black curled sandstone	-	1	0	0
Light grey sandstone	-	8	0	0
Black arenaceous slate	-	1	1	6
Clay ironstone	-	0	0	3
Black arenaceous slate with running balls of <i>ironstone</i> (sunk to this)		4	1	6
Clay <i>ironstone</i> , (bored from this)		0	0	3 $\frac{1}{2}$
Blue arenaceous slate	-	0	2	0
Clay <i>ironstone</i>	-	0	0	2 $\frac{1}{2}$
Blue slate	-	1	2	3 $\frac{1}{2}$
Soft grey slaty sandstone	-	1	1	11
Clay <i>ironstone</i>	-	0	0	2
Blue arenaceous slate	-	0	2	10
Clay <i>ironstone</i>	-	0	0	2 $\frac{1}{2}$
Black slate	-	0	2	7
COAL	-	0	0	9
Coal seat	-	1	2	7 $\frac{1}{2}$
Blue arenaceous slate	-	1	1	10
Ironstone	-	0	0	2
Blue slate	-	0	2	10
Ironstone	-	0	0	3
Grey slaty sandstone	-	0	2	8
Carried forward	-	41	2	1 $\frac{1}{2}$
L				

	Yds.	Ft.	In.
Brought forward	41	2	1 $\frac{1}{2}$
Grey sandstone (extremely hard)	0	0	2 $\frac{1}{2}$
Total depth bored	41	2	4

NO. 25.—MAYO, NEAR CLONBROCK RIVER.

Clay	-	-	-	3	1	6
Blue slaty sandstone	-	-	-	7	1	4
Black slate clay	-	-	-	2	2	8
Clay <i>ironstone</i>	-	-	-	0	0	2
Black slate clay	-	-	-	6	1	6
Clay <i>ironstone</i>	-	-	-	0	0	2
Black slate clay	-	-	-	2	0	0
Clay <i>ironstone</i>	-	-	-	0	0	2
Black slate clay	-	-	-	1	2	0
Clay <i>ironstone</i>	-	-	-	0	0	2
Black slate clay	-	-	-	1	0	2
COAL	-	0	0	8	}	0
KELVES	-	0	1	4		
Coal seat	-	-	-	0	2	7
				26	2	5
Total depth	-	-	-	26	2	5

NO. 26.—BOREHOLE NEAR DRUMMAGH COLLIERY—

		Yds.	Ft.	In.
Clay, gravel and sand	-	24	0	6
Grey slaty sandstone	-	6	0	1
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	0	0	8
Grey slaty sandstone	-	7	0	0
Blue arenaceous slate clay	-	8	2	1
Grey slaty sandstone	-	0	0	6
Blue arenaceous slate clay	-	3	0	1
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	3	0	10
Clay <i>ironstone</i>	-	0	0	2
Black slate clay	-	0	2	10
COAL	-	0	1	0
Fire clay	-	0	2	0
Grey sandstone	-	0	0	8
Blue slate clay	-	0	1	9
Hard grey sandstone	-	0	0	9
Blue slate clay	-	0	2	1
Grey sandstone	-	0	1	5
Blue slate clay	-	0	0	8
Grey sandstone	-	0	1	0
Blue slate clay	-	0	1	7
Grey sandstone,	-	0	0	5
Blue slate clay	-	0	1	7
Grey sandstone	-	0	0	8
Blue slate clay	-	1	1	0
Carried forward				8

			Yds.	Ft.	In.
Brought forward	-		60	0	8
Hard grey sandstone	-		1	2	3
Blue slate clay	-	-	2	2	3
Clay ironstone	-	-	0	0	2
Blue slate clay	-	-	0	1	2
Hard grey sandstone	-	-	0	1	9
Blue slate clay	-	-	2	0	8
Grey sandstone	-	-	0	0	5
Blue slate clay	-	-	0	1	8
Grey sandstone	-	-	0	0	6
Blue slate clay	-	-	0	1	5
Grey sandstone	-	-	0	0	3
Blue slate clay	-	-	0	0	9
Hard grey sandstone	-	-	3	1	11
Blue slate clay	-	-	8	2	4
Hard grey sandstone	-	-	0	1	2
Blue micaceous slate clay	-	-	0	0	10
Hard grey sandstone	-	-	0	2	1
Blue slate clay	-	-	0	0	2
Hard grey sandstone	-	-	1	0	8
Blue slate clay	-	-	0	0	5
Grey sandstone	-	-	2	0	0
Blue arenaceous slate clay	-	-	2	2	6
Blue slate clay	-	-	1	2	6
Grey slaty sandstone	-	-	5	1	4
Total depth bored to			96	2	10

NO. 27.—CLONBROCK.

		Yds.	Ft.	In.
Clay sand and gravel	-	15	2	4
Brown slate clay	-	1	1	0
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	1	1	0
Grey slaty sandstone	-	1	2	5
Blue slate clay	-	3	2	1
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	0	1	4
Grey slaty sandstone	-	0	1	0
Blue slate clay	-	9	0	8
Clay <i>ironstone</i>	-	0	0	2
Blue slate clay	-	2	2	2
Clay <i>ironstone</i>	-	0	0	2
Black slate clay	-	2	0	6
COAL	-	0	1	0
Total depth	-	39	1	2

NO. 28.—HILL OF DOONANE NEAR TURNPIKE.

Blue slate clay	-	6	0	0
Black slate clay with <i>ironstone</i>	-	6	0	0
COAL	-	0	1	0
Total	-	12	1	0

BORINGS AND SINKINGS TO THE FIRST BED OF THREE FOOT COAL.

NO. 29.—NEWTOWN ENGINE PIT.

			Yds.	Ft.	In.
Clay sand and gravel	-	-	25	0	0
Blue slate clay	-	-	2	0	0
COAL	-	-	0	1	0
Soft white fire clay	-	-	0	0	8
COAL	-	-	0	0	10
Fire clay	-	-	0	1	0
Sandstone seat rock	-	-	1	1	4
Blue slate clay	-	-	1	1	2
Grey slaty sandstone	-	-	2	0	0
Grey calcareous sandstone	-	-	0	1	0
Black slate clay with ironstone	-	-	0	1	6
Grey calcareous sandstone	-	-	0	0	10
Grey slaty sandstone	-	-	3	0	2
Grey calcareous sandstone	-	-	4	0	0
Blue slate clay	-	-	1	0	0
Grey calcareous sandstone	-	-	1	2	2
Micaceous slate clay	-	-	0	0	9
Gray calcareous sandstone	-	-	2	2	11
Micaceous slaty sandstone	-	-	7	1	0
Black slate clay	-	-	11	2	8
COAL	-	-	1	0	8
Coal seat	-	-	1	0	7
Total			68	1	3

NO. 30.—CLONBROCK TO THE EAST OF NEWTOWN
ENGINE PIT.

		Yds.	Ft.	In.
Soil clay and gravel	-	27	1	0
COAL	-	0	2	9
Total		28	0	9

NO. 31.—PIT TO THE SOUTH OF NEWTOWN ENGINE PIT.

Soil clay and gravel	-	16	1	9
COAL	-	1	0	3
Total depth		17	2	0

NO. 32.—CLONEEN COLLIERY NEAR CRUTTYARD.

Clay	-	5	0	0
Blue arenaceous slate clay	-	1	1	6
Clay <i>ironstone</i>	-	0	0	2
Grey sandstone	-	3	1	6
Clay <i>ironstone</i>	-	0	0	3
Grey sandstone	-	1	2	8
Micaceous slate clay	-	0	0	1
Light grey sandstone	-	2	0	0
Micaceous slate clay	-	0	0	4
Light grey sandstone	-	12	1	4
Black slaty sandstone (curled)	-	2	0	0
Micaceous slate clay	-	0	0	1
Blue arenaceous slate clay	-	2	1	6
Clay <i>ironstone</i>	-	0	0	2
Blue arenaceous slate clay	-	0	1	11
Black slate clay	-	3	1	6
COAL	-	0	2	10
Total		36	0	10

NO. 33.—MASSFORD COLLIERY.

			Yds.	Ft.	In.
Soil and clay	-	-	14	2	0
Grey sandstone	-	-	0	0	7
Light grey sandstone (white stone)			0	0	2
Grey sandstone	-	-	0	1	5 $\frac{1}{2}$
Hard grey slaty sandstone	-		0	1	2 $\frac{1}{2}$
Hard blue arenaceous slate clay			0	1	11
Clay <i>ironstone</i>	-		0	0	2 $\frac{1}{2}$
Blue arenaceous slate clay	-		2	2	8
Clay <i>ironstone</i>	-	-	0	0	2
Blue slate clay	-	-	2	1	10
Clay <i>ironstone</i>	-	-	0	0	1 $\frac{1}{2}$
Blue slate clay	-	-	1	0	6
Clay <i>ironstone</i>	-	-	0	0	2
Black slate clay	-	-	1	2	11 $\frac{1}{2}$
COAL	-	-	0	2	11
Total			26	0	10 $\frac{1}{2}$

NO. 34—COOLBANE HILL—SECTION OF THE STRATA
BETWEEN THE FIRST BED OF THREE FOOT COAL,
THE DOUBLE SEAM, AND THE SECOND OR UPPER
BED OF THREE FOOT COAL.

Clay	-	-	3	1	0
Blue slate clay	-	-	7	1	0
Ironstone	-	-	0	0	2
Carried forward			10	2	2

			Yds.	Ft.	In.
	Brought forward	-	10	2	2
	Black slate clay	- -	0	2	10
	Ironstone	- - -	0	0	2
	Blue slate	- - -	3	2	11
	Ironstone	- - -	0	0	1
	Black slate	- - -	2	0	4
	CoAL	- - -	1	0	0
	Coal seat	- - -	1	0	0
	Blue slate with vegetable impressions and small nodules of ironstone, with pyrites	- -	5	2	10
Double seam.	{ CoAL	- -	0	1	0
	{ CoAL SEAT	- -	0	1	6
	{ CoAL	- -	0	1	0
	Coal seat	- -	0	1	6
	Blue arenaceous slate clay	-	12	1	0
	Grey sandstone	- -	2	1	3
	Grey slaty sandstone	-	0	1	9
	Grey sandstone	- -	1	0	7
	Grey slaty sandstone	- -	3	2	8
	Grey sandstone	- -	1	2	0 $\frac{1}{2}$
	Blue arenaceous slate clay	-	1	1	2
	Ironstone	- -	0	0	1 $\frac{1}{2}$
	Blue arenaceous slate clay	-	2	1	7
	Ironstone	- -	0	0	2
	Blue arenaceous slate clay	-	2	1	8
	Ironstone	- -	0	0	2 $\frac{1}{2}$
	Blue slate clay	- -	0	2	8
	Ironstone	- -	0	0	2
Carried forward			57	0	4 $\frac{1}{2}$

			Yds.	Ft.	In.
Brought forward	-		57	0	4 $\frac{1}{2}$
Blue slate clay	-	-	0	2	3 $\frac{1}{2}$
Ironstone	-	-	0	0	2
Blue slate	-	-	1	0	0 $\frac{1}{2}$
Ironstone	-	-	0	0	2
Blue slate	-	-	1	2	1
Ironstone	-	-	0	0	1
Black slate	-	-	1	1	10
COAL	-	-	0	2	10
Total	-	-	63	0	10 $\frac{1}{2}$

DETACHED BORINGS.

NO. 35.—LANDS OF SLATT.

Soil clay and gravel	-		10	1	0
Blue slaty sandstone	-		7	0	0
Blue slate clay	-	-	7	1	4
Grey slaty sandstone	-		6	0	7
Blue arenaceous slate clay	-		12	0	2
Black slate clay	-	-	6	2	5
Clay <i>ironstone</i>	-	-	0	3	0
Black slate clay	-	-	3	0	4
Black slate, with clay <i>ironstone</i>	-		7	1	0
Total	-	-	61	0	10

NO. 36.—LANDS OF SLATT.

		Yd.	Ft.	In.
Soil clay and gravel	-	1	1	4
Blue slate clay	-	10	0	0
Grey slaty sandstone	-	0	0	6
Total	-	11	1	10

NO. 37.—PIT OF MOYHORA.

Soil and clay	-	-	2	0	3	
Ferruginous slate clay	-	-	2	0	8	
Light grey sandstone	-	-	6	0	7	
Grey slaty sandstone	-	-	3	1	0	
Black arenaceous slate clay			0	1	7	
Clay <i>ironstone</i>	-	-	0	0	1½	
Black arenaceous slate clay	-	-	1	1	3	
Clay <i>ironstone</i>	-	-	0	0	2	
Blue arenaceous slate clay	-	-	0	1	6	
Clay <i>ironstone</i>	-	-	0	0	1½	
Blue arenaceous slate clay	-	-	1	1	2	
Clay <i>ironstone</i>	-	-	0	0	1½	
Blue arenaceous slate clay	-	-	0	1	6	
Clay <i>ironstone</i>	-	-	0	0	2	
Black slate clay	-	-	0	2	0	
		Ft. In.				
KELVE, mixed with slate	1	6	}	1	0	0
COAL	1	6				
Fire clay	-	-		0	1	6
Fire clay mixed with COAL	-	-		0	1	6
Total	-	-		21	0	2½

NO. 38.—BOREHOLE MADE BY THE GRAND CANAL
COMPANY ON THE SIDE OF AHARINAGH HILL.

	Yds.	Ft.	In.
Soil clay and gravel	1	2	3
Brown slate clay	2	1	6
COAL	0	0	3
Fire clay	0	1	6
Black slate clay	1	0	7
Grey slaty sandstone	2	0	9
Grey sandstone	2	1	7
Black arenaceous slate clay	0	0	10
Clay <i>ironstone</i>	0	0	2
Black arenaceous slate clay	2	0	4
Clay <i>ironstone</i>	0	0	1
Blue slate clay	0	1	1
Clay <i>ironstone</i>	0	0	5
Black arenaceous slate clay	2	2	6
Clay <i>ironstone</i>	0	0	1 $\frac{1}{2}$
Blue slate clay	1	2	2
Clay <i>ironstone</i>	0	0	1
Black slate clay	0	1	3
Grey slaty sandstone	0	0	10
Fireclay	1	2	11
Hard grey sandstone	0	1	8
White sandstone	1	1	9
Grey slaty sandstone	7	2	3
Blue arenaceous slate clay	2	1	1
Black slate clay	6	0	1
Carried forward	39	1	0 $\frac{1}{2}$

		Yds.	Ft.	In.
Brought forward	-	39	1	0 $\frac{1}{2}$
Grey slaty sandstone	-	14	0	7
Grey sandstone	- -	14	1	0
Black slate clay	- -	9	1	4
Clay <i>ironstone</i>	- -	0	0	4
Blue slate clay	- -	18	1	0
Grey slaty sandstone	-	4	2	2
Black slate clay	- -	3	0	0
COAL	- -	0	0	2
Fire clay or coal seat	-	0	1	2
Clay <i>ironstone</i>	- -	0	0	6 $\frac{1}{2}$
Grey slaty sandstone	-	0	1	8
Black slate clay with ironstone		10	1	10
Grey slaty sandstone	-	0	0	7
Black slate clay with ironstone		2	2	3
Total depth		118	0	8

NO. 39.—GRAND CANAL COMPANY'S BOREHOLE
ON THE LANDS OF KILGOREY.

Clay and brown earth	-	10	1	8
Grey slaty sandstone	-	3	1	0
Blue slate clay	- -	4	2	5
Grey slaty sandstone	-	7	1	10
Blue slate clay	- -	28	0	1
Clay <i>ironstone</i>	- -	0	0	1
Carried forward		54	1	1

			Yds	Ft.	In.
Brought forward	-	-	54	1	1
Blue slate clay	-	-	2	0	4
Clay <i>ironstone</i>	-	-	0	0	1
Black slate clay	-	-	3	0	0
Clay <i>ironstone</i>	-	-	0	0	1
Dark blue slate clay	-	-	1	2	0
Clay <i>ironstone</i>	-	-	0	0	1½
Blue slate clay	-	-	0	2	0
Clay <i>ironstone</i>	-	-	0	0	2½
Blue slate clay with balls of clay iron-					
stone	-	-	2	0	8
Hard black slaty sandstone			3	2	7
Black arenaceous slate clay	-	-	1	2	6
Hard grey slaty sandstone			11	2	7
Clay <i>ironstone</i>	-	-	0	0	2
Blue arenaceous slate clay	-	-	5	1	6
Total depth			87	0	11

PRICES OF SINKING IN THE CASTLECOMER AND NEIGHBOURING COLLIERIES.

DEPTHS OF PITS.

	From the surface to 15 Yds.			From 15 to 30 Yards.			From 30 to 45 Yards.			From 45 to 60 Yards.		
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Slate per Yard	0 10 0	0 to 0	15 0	1 0 0	0 to 1	5 0	1 10 0	0 to 2	0 0	2 10 0	0 to 3	0 0
Slaty sandstone	1 0 0	0 to 1	10 0	1 15 0	0 to 2	5 0	2 10 0	0 to 3	0 0	3 10 0	0 to 4	0 0
Hard sandstone	1 10 0	0 to 2	0 0	2 10 0	0 to 3	0 0	3 10 0	0 to 4	0 0	4 10 0	0 to 5	0 0

PRICES OF SINKING IN THE CRYSTALLIZING AND MELTING

DELL'USO DI L. 132.



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1814

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